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Ground-Truth Area Selection and Characterization for Mine Countermeasures Tactical Environmental Data System: Final Report

PETER FLEISCHER
DAWN L. LAVOIE

Seafloor Sciences Branch
Marine Geosciences Division

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Peter Fleischer and Dawn L. Lavoie

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13. ABSTRACT *(Maximum 200 words)*

Three candidate sites were selected that are suitable as analogs for a variety of forward areas for Mine Countermeasures Tactical Environmental Data System development and testing. From an initial evaluation of 13 areas in U.S. waters and from comparison to certain forward areas, two sites (1) the Mississippi Gulf Coast/Chandeleur Island and (2) Key West, FL, and surrounding areas were chosen as the most suitable ground-truth areas. A third site, offshore of Panama City, FL, was added to take advantage of an ongoing research program, the Coastal Benthic Boundary Layer research program.

For each of the three ground-truth areas, the following is presented: (1) a summary of salient characteristics, (2) a listing of existing data bases, and (3) an annotated bibliography.

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1 INTRODUCTION

The major objective of the Mine Countermeasures (MCM) Tactical Environmental Data System (MTEDS) is to provide the MCM force with a capability to make in situ measurements of critical environmental parameters before and during MCM operations in such a way that the information is entered directly into planned upgrades of tactical combat systems for the *Avenger-* and *Osprey*-class MCM ships. This objective is articulated in the MTEDS Program Master Plan (Naval Research Laboratory, 1992). One of the goals of MTEDS is to provide the MCM force with a capability to measure active acoustic reverberation statistics, sound speed, and water current velocity from the surface to the bottom, sediment geophysical characteristics, and environmental electrical properties and water depth required for determining magnetic swept-path parameters (MTEDS Master Program Plan). To achieve these goals, the MTEDS program was structured into eight technical tasks; the first task was the selection and characterization of ground-truth areas.

2 APPROACH

This report documents the two issues addressed in Task 1. The first is the rationale and characteristics required for ground-truth area Selection. The second is the characterization of the selected ground-truth areas, or test sites.

3 TEST SITE SELECTION PROCESS

Selection of test sites was approached from two directions. First, the environmental characteristics and general suitability of various potential sites within United States waters were evaluated. Second, the environmental properties of a set of forward areas were examined for potential simulation at a test site. The resultant selected test sites represent a compromise between the constraints of the available sites and the desired properties based on the forward areas.

3.1 Evaluation of Candidate Sites

A number of shallow marine locations in the United States were considered as potential test sites for MTEDS and for other shallow-water MCM uses (Table 3.1-1). The sites were evaluated in terms of the following criteria:

- similarity to forward areas of naval interest
- logistical convenience
- available historical environmental data bases
- environmental variability
- planned future surveys by the Naval Oceanographic Office (NAVOCEANO) and other groups
- strategic importance

Table 3.1-1. List of potential test sites considered for MTEDS.

U. S. Gulf of Mexico Coast:
- Texas continental shelf off Ingleside
- Continental shelf and slope of the Mississippi Gulf Coast, including the Chandeleur Islands
- Florida continental shelf off Panama City
- Key West, FL, and surrounding platforms and terraces, including the Florida Strait

U. S. Atlantic Coast:
- Newport, RI, Narragansett Bay and approaches
- Long Island Sound and approaches
- Norfolk, VA, and approaches
- Charleston, SC, and approaches
- Northern Florida Atlantic continental shelf

U. S. Pacific Coast:
- Strait of Juan de Fuca, Puget Sound, and the Washington continental shelf
- San Diego, CA and approaches

Bahamas:
- Atlantic Underwater Testing and Evaluation Center (AUTEC), Tongue of the Ocean (TOTO)
- Carbonate banks

Hawaii:
- Ocean Thermal Energy Conversion site (OTEC), Oahu
- Barking Sands, Kauai

The test site evaluation builds on and amplifies an approach developed by Fleischer (1981) for the Buried Mine Minehunting System (BURMMS) to evaluate test sites for activities related to mine burial. Potential sites are presented in a tabular format, consisting of uniformly defined evaluation criteria that facilitates site comparisons. This approach provides the user with the means to develop objective rankings of the sites. The tabulation of characteristics for each of the sites is presented in Tables 3.1-2 to 3.1-15.

Table 3.1.-2. Texas Shelf: Information sheet for potential MTEDS test sites.

SITE	SIMILARITY TO FORWARD AREAS	LOGISTICAL CONVENIENCE	AVAILABLE DATA BASE	ENVIRONMENTAL VARIABILITY	PLANNED NAVOCEANO SURVEYS	STRATEGIC IMPORTANCE
	GEOLOGY	***PORTS***	***MINE PILOTS***	***GEOLOGY***	Planned	Moderate
TEXAS SHELF / INGLESIDE	Thick sediments and more uniform than typical shelf regions	Galveston Houston Corpus Christi	No	Sediment type: terrigenous Grain size: almost all sands, hard grounds at the shelf edges in some locations Variability: very little, only variability is slight differences in sands over time, considered one of the more homogeneous sites available Substructure: sands for 100's of m		
		LABS	***NRL***	***HYDROGRAPHY***		
		MCM base proposed UT at Port Aransas TAMU at Galveston	Previous assessment done on the shelf for Project Gemini (AEAS)	Temperature: not determined Salinity: not determined Conductivity: not determined Currents: not determined Tides: not determined Visibility: not determined		
		OTHER SUPPORT	***OTHER***	***ACOUSTICS***		
		Industrial base: good	Considerable: LATEX data available Oil Co. inf. TAMU research, etc.	Reverberation: low Variability: low Sound Velocity: not determined Sound Velocity Gradient: not determined		

Comments:
- This is considered to be one of the most homogeneous sites possible. Could use as a baseline site but would have to transfer to another site to get significant bottom variability.
- NAVOCEANO plans to survey this area in the next year.

Table 3.1.-3. Mississippi Gulf Coast/Chandeleurs: Information sheet for potential MTEDS test sites.

SITE	SIMILARITY TO FORWARD AREAS	LOGISTICAL CONVENIENCE	AVAILABLE DATA BASE	ENVIRONMENTAL VARIABILITY	PLANNED NAVOCEANO SURVEYS	STRATEGIC IMPORTANCE
	GEOLOGY	***PORTS***	***MINE PILOTS***	***GEOLOGY***	None	Moderate
CHANDELEURS AND SOUTH	Can find all the elements of shelf environments except bare rock & glacial moraine. Similar to S. Korea, Philippines, Gulf of Sidra.	Gulfport New Orleans Biloxi (available for small craft) Pascagoula	Yes	Sediment type: terrigenous Grain size: sands, silts, clays Variability: highly variable, including layering, gassy sediments, hardgrounds (oyster beds) within reasonable small geographic region; also includes mouth of the Mississippi in this area with fine grained, underconsolidated sediments with low shear strength and stability Substructure: sediment for hundreds of mbsf		
		LABS	***NRL***	***HYDROGRAPHY***		
		NRLSSC NAVOCEANO	Considerable: 1. Ship Island and south -ASCS, cores, etc., 2. Previous assessment - sig. data base in house	Temperature: 9°C (winter); 31°C (summer) Salinity: 12-33 ppt (inner); 30-34 ppt (outer); 35-37 ppt (offshore) Conductivity: 29-58 mmho/cm Current: primarily tidal; 0.1-0.6 m/s Tides: 0.05-0.80 m Visibility: 0.3-1.8 m (inner); 5-10 m (outer); 12-20 (offshore)		
		OTHER SUPPORT	***OTHER***	***ACOUSTICS***		
		Industrial base: good rental ships available (R/V *Tommy Munro* and R/V *Kit Jones*)	Considerable: Texas A&M (Gyre seismic survey) USGS & MMS including oil co. logging data Multiple research by others	Reverberation: variable depending on bottom type Variability: significant Sound Velocity: not determined Sound Velocity Gradient: insignificant, variable due to seasonal temperature changes		

Comments:
- Includes Mississippi River Fan, with fine grained sediments, extremely soft bottom and unstable conditions, gassy sediments which are good testing conditions for electromagnetic (EM) surveys.
- Can test over a variety of conditions within a relatively small area.
- Water depths are shallow to shelf edge, or over the slope to deeper depths if desired.
- Year-round operations possible.
- USGS plans to survey Mobile Bay and vicinity over the next year.

Table 3.1.-4. Panama City, Florida: Information sheet for potential MTEDS test sites.

SITE	SIMILARITY TO FORWARD AREAS	LOGISTICAL CONVENIENCE	AVAILABLE DATA BASE	ENVIRONMENTAL VARIABILITY	PLANNED NAVOCEANO SURVEYS	STRATEGIC IMPORTANCE
	GEOLOGY	*PORTS*	*MINE PILOTS*	*GEOLOGY*	None	Low
PANAMA CITY	Similar to Ingleside: thick sands on shelf, mud & fine-grained sediments in estuaries	Panama City Pensacola Mobile	Yes	Sediment type: terrigenous Grain size: sands and muds; some shelly areas Variability: low Substructure: fine-scale layering; little structure		
	HYDROGRAPHY	*LABS*	*NRL*	*HYDROGRAPHY*		
	Not typical of shelves with less sediment input	Coastal Systems Station (CSS) - Panama City	Considerable data available	Temperature: 15-30°C (winter-summer); variable inshore and inner shelf Salinity: 30-34 ppt (inner shelf - offshore); variable inshore Conductivity: 32-58 mmho/cm Currents: wind & tidal; ~0.5 (summer) - 1.2 (winter) Tides: diurnal; 0.5-1.2 m range; rotary Visibility (Secchi): 5-23 m (inner shelf - offshore)		
		OTHER SUPPORT	*OTHER*	*ACOUSTICS*		
		Industrial base: good Rental ships available CSS facilities Convenient	GOM surveys & inf. available CSS surveys	Reverberation: moderate to moderately high Variability: moderate Sound Velocity: 1520-1540 (inner shelf - offshore) (spring - fall) Sound Velocity Gradient: insignificant		

Comments:
- Year-round operations.
- Soft muds (clay & silts) in estuaries.
- Sands seaward of barrier islands.
- Less variability than Chandeleur area.

Table 3.1.-5. Key West, Florida: Information sheet for potential MTEDS test sites.

SITE	SIMILARITY TO FORWARD AREAS	LOGISTICAL CONVENIENCE	AVAILABLE DATA BASE	ENVIRONMENTAL VARIABILITY	PLANNED NAVOCEANO SURVEYS	STRATEGIC IMPORTANCE
	GEOLOGY	***PORTS***	***MINE PILOTS***	***GEOLOGY***	None	High
KEY WEST (including the terrace to the north and south and the Straits of Florida)	Similar to bottom types of Cuba, N. Red Sea, and Panama on shelf and terraces	Key West	No	Sediment type: carbonates Grain size: muds to sands and gravels, shells and reefal debris Variability: highly variable Substructure: limestone basement (old Cretaceous reef); some layered areas just surveyed by G. Shinn, USGS		
	HYDROGRAPHY	***LABS***	***NRL***	***HYDROGRAPHY***		
	Current regime in this area is similar to that in many world straits, such as Sicily, Hormuz, and Korea	NADC office - program logistic support David Taylor Underwater Explosives Research Division COOP units with platform	NOARL Rep 185 Future ASCS survey planned for purpose of building carbonate data base	Temperatures and sound profiles available and similar to other south Florida regions Current is variable between quiet terrace and shelf conditions, through Gulf Stream Current conditions Other data available but not in hand		
		OTHER SUPPORT	***OTHER***	***ACOUSTICS***		
		Industrial base: good Key West Naval Air Station NADC program office Inexpensive and convenient	Multer, 1977; Doyle & Holmes 1985; Ebeniro et al., 1986; Jordan et al, 1964; Klitgord & Popenoe, 1984; Mallowy & Hurley, 70; USGS, etc.	Reverberation: low to high depending on location Variability: considerable		

Comments:

- Key West area includes both quiet, shallow-water shelf environment to the north and south of the keys and Tortugas, and the more active regime in the Straits of Florida to the south.
- It is a strategic passage in itself as well as acting as an analog to some of the other forward area Straits.
- Although the keys have been made a Marine Sanctuary, NOAA has assured the MTEDS program that work may be conducted here. NOAA is mainly concerned about dredging and similar destruction of the shallow-water reefs.
- Logistic support inexpensive; convenient.

Table 3.1.-6. Newport, Rhode Island: Information sheet for potential MTEDS test sites.

SITE	SIMILARITY TO FORWARD AREAS	LOGISTICAL CONVENIENCE	AVAILABLE DATA BASE	ENVIRONMENTAL VARIABILITY	PLANNED NAVOCEANO SURVEYS	STRATEGIC IMPORTANCE
	GEOLOGY	***PORTS***	***MINE PILOTS***	***GEOLOGY***	None	Moderate
NEWPORT, RI (Narragansett Bay & approaches)	Similar to other glacial-sedimented shelves, such as N. Korea	Newport New London Narragansett - Univ. of Rhode island (URI)	Yes	Sediment type: terrigenous Grain size: mud, reworked sand, rock outcrops, glacial moraine sediments (irregular grain size distribution) Variability: high Substructure: granite		
		LABS	***NRL***	***HYDROGRAPHY*** (summer)		
		Naval undersea Systems Center Univ. of Rhode Island Woods Hole Oceanographic Institution (WHOI)	Limited	Temperature: 23-28°C Salinity: 21-35 ppt Conductivity: >30 mmho/cm Currents: ~0.6 m/s Tides: semidiurnal; ~ 1.0 m range Visibility: ~10 m		
		OTHER SUPPORT	***OTHER***	***ACOUSTICS*** (scarcity of data)		
		Industrial base: good	Open literature (much data seems to be geochemical)	Reverberation: high Variability: high Sound Velocity: 1500 m/s Sound Velocity Gradient: insignificant		

Comments:
- Seasonal operations only.
- Narragansett Bay provides a well-protected environment in which to work, except for winter.
- The approaches are typical northern shelves with considerable lateral variability.

Table 3.1.-7. Long Island Sound: Information sheet for potential MTEDS test sites.

SITE	SIMILARITY TO FORWARD AREAS	LOGISTICAL CONVENIENCE	AVAILABLE DATA BASE	ENVIRONMENTAL VARIABILITY	PLANNED NAVOCEANO SURVEYS	STRATEGIC IMPORTANCE
	GEOLOGY	***PORTS***	***MINE PILOTS***	***GEOLOGY***	None	High
LONG ISLAND, BLOCK ISLAND, RHODE ISLAND SOUNDS	Northern shelf regions, such as N. Korea	Newport New London	Yes	<u>Sediment type</u>: terrigenous, glacial moraine <u>Grain size</u>: coarse to medium (in estuaries & deep water) <u>Variability</u>: highly variable; sands & gravel immediately off shelf and mud to mud-sand at >200-m depth		
		LABS	***NRL***	***HYDROGRAPHY*** (summer)		
		Naval Ocean Systems Center (NOSC) URI, WHOI	Not in hand, but available Good cooperation with URI	<u>Temperature</u>: 20-28°C <u>Salinity</u>: 21-35 ppt <u>Conductivity</u>: >30 mmho/cm <u>Currents</u>: ~0.6 m/s, generally weak over shelf region, stronger in the Race <u>Tides</u>: semidiurnal; ~ 1.0 m range <u>Visibility (Secchi)</u>: ~10 m		
		OTHER SUPPORT	***OTHER***	***ACOUSTICS*** (scarcity of data)		
		<u>Industrial base</u>: good	Open literature USGS	<u>Reverberation</u>: high <u>Variability</u>: moderate to high; bottom clutter problem; sonar performance(?) over hard & rocky outcrop areas is poor <u>Sound Velocity</u>: ~1500 m/s <u>Sound Velocity Gradient</u>: insignificant		

Comments:
- Fishing activity intense.
- Seasonal operations limited to spring, summer, fall.
- Some areas (especially the Race) have strong currents (~3 m/s) and can simulate critical straits on a small scale.

Table 3.1.-8. Norfolk, Virginia: Information sheet for potential MTEDS test sites.

SITE	SIMILARITY TO FORWARD AREAS	LOGISTICAL CONVENIENCE	AVAILABLE DATA BASE	ENVIRONMENTAL VARIABILITY	PLANNED NAVOCEANO SURVEYS	STRATEGIC IMPORTANCE
	GEOLOGY	***PORTS***	***MINE PILOTS***	***GEOLOGY***	None	yes
NORFOLK, VA	Typical terrigenous shelf such as S. Korea, Philippines, Gulf of Sidra	Norfolk	Yes	Sediment type: terrigenous Grain size: sand, silt, clay Variability: variable		
		LABS	***NRL***	***HYDROGRAPHY*** (summer)		
		NRL main Multiple others including universities (e.g. Old Dominion Univ., Va. Inst. of Marine Science (VIMS)	Good historical data in-house	Temperature: 20-25°C Salinity: 32 ppt offshore; variable inshore Conductivity: 38-45 mmho/cm ; variable inshore Currents: spatially variable; tidal, wind, density; 0.1-0.5 m/s or more Tides: semidiurnal; 0.4-0.6 m/s Visibility (Secchi): 1 m inshore; ~20 m offshore		
		OTHER SUPPORT	***OTHER***	***ACOUSTICS***		
		Industrial base: good Rental, Navy ships	Considerable open literature NAVOCEANO (13 cores)			

Comments:
- Typical shelf situation; no advantage over Charleston or Jacksonville.
- High traffic area.
- Variable currents, may be high depending on conditions and area.

Table 3.1.-9. Charleston, South Carolina: Information sheet for potential MTEDS test sites.

SITE	SIMILARITY TO FORWARD AREAS	LOGISTICAL CONVENIENCE	AVAILABLE DATA BASE	ENVIRONMENTAL VARIABILITY	PLANNED NAVOCEANO SURVEYS	STRATEGIC IMPORTANCE
	GEOLOGY	***PORTS***	***MINE PILOTS***	***GEOLOGY***	None	Moderate
CHARLESTON, SC	Terrigenous shelf, such as S. Korea, Philippines, Gulf of Sidra	Charleston, SC Charleston Naval Base	Yes	Sediment type: terrigenous Grain size: fine sediments in harbor; shelf is sandy with shelly areas Variability: moderate lateral variability Substructure: variable; sand ripples		
		LABS	***NRL***	***HYDROGRAPHY***		
		COMINEWARCOM	Experiments Bottom data	Temperature: 20-28°C (shelf) Salinity: 34-36 ppt (shelf) Conductivity: 35-56 mmho/cm Currents: 0.2-0.8 m/s (shelf to offshore) Tides: semidiurnal; 1.5 m range Visibility (Secchi): 5-15 m		
		OTHER SUPPORT	***OTHER***	***ACOUSTICS***		
		Industrial base: good Probable ships for hire	Open literature Academic data base COST GE-1 and other wells on shelf	Reverberation: low - moderate inshore; moderate - high offshore Variability: variable in areas of fresh water influx Sound Velocity: 1515-1527 m/s (spring - fall) Sound Velocity Gradient: insignificant		

Comments: • Wide shelf area with low to moderate currents, Gulf Stream influence at shelf edge.

Table 3.1.-10. Jacksonville/Mayport, Florida: Information sheet for potential MTEDS test sites.

SITE	SIMILARITY TO FORWARD AREAS	LOGISTICAL CONVENIENCE	AVAILABLE DATA BASE	ENVIRONMENTAL VARIABILITY	PLANNED NAVOCEANO SURVEYS	STRATEGIC IMPORTANCE
	GEOLOGY	***PORTS***	***MINE PILOTS***	***GEOLOGY***	None	High
JACKSONVILLE/ MAYPORT, FL	Shelf area near demarcation between terrigenous and carbonate. Can find places that are similar on other strategic shelves, such as Philippines, Gulf of Sidra, N. Red Sea	Jacksonville	Yes	Sediment type: terrigenous grain size: sands and other coarse grained sediments cover most of the shelf, harbors and estuaries, and areas deeper than 600 m are floored with muds variability: typical shelf conditions, lateral variability		
		LABS	***NRL***	***HYDROGRAPHY***		
			Considerable data available (preassessments, etc.)	Temperature: 14°C winter; 28°C summer Salinity: 32-37 ppt Conductivity: 30-56 mmho/cm (near and offshore); Currents: wind and tide, Gulf Stream eddies, 0.2-1.0 m/s Tides: semidiurnal; 1.5-2.0 m Visibility: 2 m inshore, 30+ m offshore		
		OTHER SUPPORT	***OTHER***	***ACOUSTICS***		
		Industrial base: good	Open literature USGS shelf data COST GE-1 and other wells on shelf	Reverberation: low-moderate inshore; moderate - high offshore depending on bottom type Variability: moderate, typical shelf conditions Sound Velocity: 1494-1533 m/s Sound Velocity Gradients: insignificant		

Comments:
- Base is conveniently located, but small and extremely busy.
- High traffic area.
- Sandy shelf; essentially no fine-grained sediments offshore.

Table 3.1.-11. Florida Atlantic shelf: Information sheet for potential MTEDS test sites.

SITE	SIMILARITY TO FORWARD AREAS	LOGISTICAL CONVENIENCE	AVAILABLE DATA BASE	ENVIRONMENTAL VARIABILITY	PLANNED NAVOCEANO SURVEYS	STRATEGIC IMPORTANCE
	GEOLOGY	***PORTS***	***MINE PILOTS***	***GEOLOGY***	None	
FLORIDA ATLANTIC SHELF	Similar to Panama, Cuba, N. Red Sea, & other warm shelf regions	Port Everglades W. Palm Beach	No	Sediment type: carbonate Grain size: sands including oolites and shells, rocky outcrops in places, frequently less than 6" sed. on shelf, mud in shallow bays and lagoons Variability: high Substructure: limestone basement (Cretaceous reef)		
		LABS	***NRL***	***HYDROGRAPHY***		
		AUTEC Lab support in W. Palm Beach FIT, RSMAS	Fairly extensive historical data in-house	Similar to Jacksonville but nearshore confined to a narrow shelf (~1-3 nm wide), then Gulf stream influence off the shelf		
		OTHER SUPPORT	***OTHER***	***ACOUSTICS***		
		Industrial base: good (but expensive)	Considerable: University data (U. Miami in particular) USGS	Reverberation: moderate to high depending on bottom type Variability: moderate		

Comments:

- Very expensive; not recommended from a cost point of view, although all the necessary support is available.
- Proximity to the Gulf Stream will produce currents that are similar to those in strategic straits (bottom will be coral rubble), but the actual Gulf Stream will be difficult to work in (and water depths too deep).
- Heavy shipping traffic.
- It will be difficult to find a fine-grained site that is also deep enough to work in.

Table 3.1.-12. Strait of Juan de Fuca region: Information sheet for potential MTEDS test sites.

SITE	SIMILARITY TO FORWARD AREAS	LOGISTICAL CONVENIENCE	AVAILABLE DATA BASE	ENVIRONMENTAL VARIABILITY	PLANNED NAVOCEANO SURVEYS	STRATEGIC IMPORTANCE
	GEOLOGY	*PORTS*	*MINE PILOTS*	*GEOLOGY*	None	High
JUAN DE FUCA/ PUGET SOUND/ WASHINGTON COAST	Glacial moraine, similar to other northern shelf regimes, e.g. Korean shelf	Seattle Numerous commercial facilities	Yes	Sediment type: shelves are sands and sills; protected areas are muds; significant amounts of glacial till on the shelf which results in unpredictability of bottom type without specific surveys, rocks and outcrops on the shelf Variability: highly variable laterally Substructure: thin sediment cover, outcrops		
	HYDROGRAPHY	*LABS*	*NRL*	*HYDROGRAPHY* (summer)		
	Currents & bottom conditions in restricted areas approach those of several forward choke points but on smaller geographical scale, e.g., St. of Gibraltar	Naval facilities available [Univ. Washington, Oregon State]	Considerable: including ASCS, AEAS experiments and assessments, etc.	Temperature: 13°C, surface; strong gradients Salinity: 31 ppt Conductivity: > 30 mmho/cm Currents: 0.5 m/s av. offshore; strong tidal currents of 3 - 6 m/s through narrow passages Tides: semidiurnal; ~ 1.2 m Visibility: 10 m		
	ACOUSTICS	*OTHER SUPPORT*	*OTHER*	*ACOUSTICS*		
	Complex	Industrial base: good	Extensive: Univ. Wash, OSU, contractors USGS shelf data NOAA in deeper areas	Reverberation: low - high Variability: high Sound Velocity: variable Sound Velocity Gradient: strong gradients		

Comments:
- Puget Sound has heavy ship traffic and strong currents in restricted areas.
- Strait of Juan de Fuca is strategically important; large data base available.
- Washington coast is similar to above; large data base available.

Table 3.1.-13. San Diego, California: Information sheet for potential MTEDS test sites

SITE	SIMILARITY TO FORWARD AREAS	LOGISTICAL CONVENIENCE	AVAILABLE DATA BASE	ENVIRONMENTAL VARIABILITY	PLANNED NAVOCEANO SURVEYS	STRATEGIC IMPORTANCE
	GEOLOGY	***PORTS***	***MINE PILOTS***	***GEOLOGY***	None	High
SAN DIEGO, CA	Similar to shelf regime in Gulf of Sidra, Philippines, and other northern shelf areas	San Diego San Diego Naval Base	Yes (bottom data very sketchy)	Sediment type: terrigenous Grain size: shelf, sand and rocks, typical shelf regime; in the bays and estuaries, fine muds Variability: significant There is extensive marine kelp around the rocks and approaches to San Diego.		
		LABS	***NRL***	***HYDROGRAPHY***		
		Naval Civil Engineering Lab. (NCEL) NOSC Moffet Field	Limited	Temperature: 13-21°C Salinity: 34 ppt outside Conductivity: 41-44 mho/cm Currents: tidal and wind: 0.2 - 1.5 m/s (bay)/0.9 m/s (ocean) Tides: semidiurnal; 1.1-1.3 m Visibility: 5-9 m		
		OTHER SUPPORT	***OTHER***	***ACOUSTICS***		
		Industrial base: good NCEL for logistics	Considerable: NCEL, USGS shelf data, Scripps, other university data, etc.	Reverberation: high, considerable clutter due to rough and rock bottom, decreases seaward Variability: significant Sound Velocity: 1500 m/s summer Sound Velocity Gradient: insig. in bay, strong outside		

Comments:
- Heavy fishing activity, moderate shipping.
- Kelp beds in rocky areas would not be conducive to minehunting.

Table 3.1.-14. Bahamas: Information sheet for potential MTEDS test sites.

SITE	SIMILARITY TO FORWARD AREAS	LOGISTICAL CONVENIENCE	AVAILABLE DATA BASE	ENVIRONMENTAL VARIABILITY	PLANNED NAVOCEANO SURVEYS	STRATEGIC IMPORTANCE
	GEOLOGY	***PORTS***	***MINE PILOTS***	***GEOLOGY***	None	
BAHAMAS	Carbonate banks typical of other Caribbean regions ~~(Cuba, Panama)~~	West Palm Beach Port Everglades	No	<u>Sediment type</u>: 100% carbonate <u>Grain size</u>: turbidite deposition, so a mix of sand and muds; distribution is regular and predictable large stromatolites on the floor of the TOTO. Banks have sand-size sediments, oolites, and other debris <u>Variability</u>: considerable <u>Substructure</u>: limestone basement		
		LABS	***NRL***	***HYDROGRAPHY***		
		AUTEC	Limited	<u>Temperature</u>: not determined <u>Salinity</u>: not determined <u>Conductivity</u>: not determined <u>Currents</u>: strong enough to winnow fines on shelves <u>Tides</u>: not determined <u>Visibility</u>: not determined <u>Sound Velocity</u>: not determined <u>Sound Velocity Gradient</u>: not determined		
		OTHER SUPPORT	***OTHER***	***ACOUSTICS***		
		<u>Industrial base</u>: good AUTEC support office in W. Palm Beach Some support on Andros but limited	Various sources: Academia, USGS, various researchers Significant amounts on banks and portions of the Bahamas	<u>Reverberation</u>: variable <u>Variability</u>: significant		

Comments:

- Shallow water shelf areas are limited in the TOTO, reaches slope depths to 2000 m quickly.
- Shelves may provide good analogs for other carbonate environments in strategic areas.
- Some coordination with Bahamian government may be necessary, depending on site.
- Distance from land requires more lead time for experiments. Must load, etc., in Florida and transit to required sites.

Table 3.1.-15. Hawaii: Information sheet for potential MTEDS test sites.

SITE	SIMILARITY TO FORWARD AREAS	LOGISTICAL CONVENIENCE	AVAILABLE DATA BASE	ENVIRONMENTAL VARIABILITY	PLANNED NAVOCEANO SURVEYS	STRATEGIC IMPORTANCE
	GEOLOGY	***PORTS***	***MINE PILOTS***	***GEOLOGY***	None	Pearl Harbor
HAWAII: OTEC (Oahu) Barking Sands (Kauai)	Volcanic atoll geology, similar to S. Pacific islands	Pearl Harbor Honolulu	Yes	Sediment type: volcanic & coarse near shore Grain size: sands to mud (deep); sand to silt (shelves); rock (flanks) Variability: high Substructure: volcanic layering; typical volcanic island morphology		
	HYDROGRAPHY	***LABS***	***NRL***	***HYDROGRAPHY***		
	Open sea	University of Hawaii		Temperature: ~25°C Salinity: 35 ppt Conductivity: ~53 mmho/cm Currents tidal and wind; 0.2-0.5 m/s Tides: semidiurnal; 0.5-1.0 m range; rotary Visibility (Secchi): >35 m offshore, less nearshore		
		OTHER SUPPORT	***OTHER***	***ACOUSTICS***		
		Industrial base: good Rental ships possible	Literature USGS: good primary source	Reverberation: low-high Variability: high Sound Velocity: ~1530 m/s Sound Velocity Gradient: insignificant		

Comments:
- High shipping and travel costs. Expensive for short tests, but possibly good for large-scale MCM field test.
- Year-round working conditions.
- Open ocean seas.

3.2 Forward Areas

Selection of ground-truth areas presupposes that they serve as analog sites for *forward areas* which may be difficult to access for logistic or political reasons. A suitable ground-truth area, in addition to being accessible, should mirror environmental conditions of forward areas. The suitability of a ground-truth area is thus determined by the fidelity with which it substitutes for a given forward area, as well as by the number of forward areas it may represent.

Forward areas of interest may be divided into two general categories, *straits* and *shallow-water environments*. Beside the geographic and geomorphic characteristics of straits, the two categories have distinguishing environmental settings. Straits are characterized by coarse sediments, and have strong tidal or geostrophic currents, typically greater than 1 m/s (2 kt). In shallow-water environments, which here include semi-enclosed seas, sediments are generally finer; currents are moderate to strong and are predominantly tidal. A partial list of forward areas is shown in table 3.2-1.

Table 3.2-1. Partial list of forward areas.

Straits:
- Gibraltar
- Sicily
- Hormuz
- Malacca and Singapore

Shallow-Water Environments:
- Persian Gulf
- Gulf of Oman
- Gulf of Aden
- Red Sea
- Gulf of Sidra
- Northeast Adriatic
- Panama
- Cuba
- Korea (east coast)
- Yellow Sea

Tables 3.2-2 to 3.2-15 contain an unclassified listing of the salient environmental characteristics of these forward areas. Divided into categories of geology, hydrography, and acoustics, these characteristics are important to consider when choosing analog ground-truth areas for MTEDS.

Table 3.2-2. Gibraltar: Forward area characteristics, straits.

Geology

•Bathymetry: Atlantic side: broad (25-40 km) shelf, regular slope; central portion: narrow (1-15 km) shelves, steep-sided, deep basin (>240 m)
•Sediment type: coarse, gravel and rocks; shelf sediments on Atlantic side are gravel; mud-sand and sand to the NW; mud is found deeper than 30 m
•Substructure: boundary between African and Eurasian plates; complex structure; faulted and folded sedimentary rocks

Hydrography

•Temperature: 14-22°C (winter-summer)
•Salinity: ~36 ppt (surface); ~38 ppt (bottom)
•Conductivity:
•Currents: both tidal and nontidal surface currents; 0.7-2.0 m/s; ; bottom currents ~1.0 m/s
•Tides: Semidiurnal; range ~0.8m
•Visibility (Secchi): 15-25 m
•Seas: >1.0 m more than 60% of the time; east or west depending on wind

Acoustics

•Reverberation: high
•Reverberation Variability: low-moderate
•Sound Velocity: ~1520 m/s
•Sound Velocity variability: moderate, negative gradient

Table 3.2-3. Sicily: Forward area characteristics, straits.

Geology

•Bathymetry: relatively narrow coastal shelves; moderately irregular bottom in strait
•Sediment type: sand and rock nearshore, mud offshore
•Substructure: very complex; folded and faulted sedimentary rocks at varying depths below layered muds and turbidites

Hydrography

•Temperature: 14-25°C (winter-summer); isothermal in winter; stratified to 200 m in summer
•Salinity: ~37.0-37.5 ppt year-round
•Conductivity: ~44-56 mmho/cm (winter-summer); profile follows that of temperature
•Currents: generally ~0.2 m/s; surface currents affected by wind, at times reaching 2.0 m/s; subsurface currents, 0.2-0.6 m/s
•Tides: semidiurnal; max. range = 2.7 m
•Visibility (Secchi): ~25 m

Acoustics

•Reverberation: low to high in coastal areas
•Reverberation Variability: moderate
•Sound Velocity: 1515-1540 m/s summer; ~1510 m/s winter
•Sound Velocity variability: decreasing with depth in summer; monotonous in winter

Table 3.2-4. Hormuz: Forward area characteristics, straits.

Geology
- Bathymetry: generally 80-100 m deep
- Sediment type: mud-sand with high proportion of sand with some gravel; high carbonate (80%) (shell and coral); moderate variability
- Substructure: complex; ancient subduction zone with melanges and ophiolites in sedimentary rocks

Hydrography
- Temperature: high, >30°C, variable due to wind; strong horizontal and vertical gradients
- Salinity: very high, generally ~43 ppt, but may exceed 50 ppt; strong horizontal and vertical gradients (bottom water is more saline)
- Conductivity:
- Currents: 0.2-0.6 m/s, max. of 2.5 m/s; surface currents mainly tidal and complex, strongly affected by wind
- Tides: mixed, causing complex currents; range ~2.0 m
- Visibility (Secchi): 15-25 m

Acoustics
- Reverberation: Probably high
- Reverberation Variability: Probably moderate
- Sound Velocity: 1535 m/s
- Sound Velocity variability: low variability

Table 3.2-5. Straits of Malacca and Singapore: Forward area characteristics, straits.

Geology
- Bathymetry: shallow, mostly 20-50 m; generally no deeper than 100 m; Malacca: moderately irregular, Singapore: irregular coral hummocks
- Sediment type: Malacca: predominantly mud, muddy sand with areas of gravel, rock, shell, and coral. Singapore: heterogeneous: mud, muddy sand, sand, gravel, rock, shell, coral; coral reefs and hummocks
- Substructure: rock and cemented carbonates

Hydrography
- Temperature: 32-33°C. Malacca: isothermal to ~30 m. Singapore: isothermal
- Salinity: 28.0-32.0 ppt , stratified
- Conductivity:
- Currents: predominantly tidal and wind driven (monsoons); complex, 0.7-1.5 m/s
- Tides: semidiurnal and diurnal; range?
- Visibility (Secchi): 1-7 m

Acoustics
- Reverberation: Malacca: low - high, Singapore: high
- Reverberation Variability: Malacca: intermediate, Singapore: high
- Sound Velocity: ~1540-1550 m/s, surface, in winter
- Sound Velocity variability: low

Table 3.2-6. Persian Gulf: Forward area characteristics, shallow-water environments.

Geology: Semi-enclosed sea, communicating with the Arabian Sea through the Strait of Hormuz; Tigris and Euphrates River deltas at northern end.
•Bathymetry: generally 200 m or less; primarily sedimentary topography, with some coral reefs
•Sediment type: terrigenous clays/silts plus shell and coral detritus; mud, sand, shell, and coral heads
•Substructure: unconsolidated and semiconsolidated sediments generally <1 km deep, underlain by three crustal layers of increasing density

Hydrography: Strongly affected by seasonal monsoons: northeast winter monsoon from November through March (wet season); southwest summer monsoon from May through September (dry season)
•Temperature: very high, >30°C during summer; high seasonal variability; strong horizontal and vertical gradients, especially during summer
•Salinity: very high, ~40 ppt; seasonally variable; strong horizontal and vertical gradients
•Conductivity: High and variable
•Currents: primarily tidal and complex; 0.2-0.6 m/s
•Tides: both diurnal and semidiurnal, depending on location; successive heights variable; ranges of 1.4 to as much as 4.9 m, depending on location
•Visibility (Secchi): ~15-20 m, less in winter

Acoustics
•Reverberation: negligible to high
•Reverberation Variability: now variability on local scale
•Sound Velocity: 4950-5100 m/s (winter, summer)
•Sound Velocity variability: now in winter, moderate in summer

Table 3.2-7. Gulf of Oman: Forward area characteristics, shallow-water environments.

Geology: Continental shelf to north and west
•Bathymetry: narrow, smooth shelf, flat to mild slopes
•Sediment type: mud and mud-sand; well sorted; moderate calcium carbonate content (~35%)
•Substructure: adjacent to ancient subduction zone; deformed rocks with ophiolites and melanges

Hydrography: Similar to Persian Gulf, but more oceanic influence. Shelf area influenced by short-term variations in runoff, evaporation, currents, etc.
•Temperature: annual surface temp range: 25-32°C; highly stratified in summer
•Salinity: annual range: ~36.5-37.0 ppt; stratified near Strait of Hormuz (highly saline water flowing out the bottom of the strait)
•Conductivity: high
•Currents: wind driven; predominantly counterclockwise
•Tides: mixed on shelf; range ~1.6 m
•Visibility (Secchi): 15-20 m

Acoustics
•Temperature: probably moderate
•Temperature Variability: probably low
•Sound Velocity: ~1520 m/s
•Sound Velocity variability: stratified, negative gradient with depth; dependent on monsoon conditions

Table 3.2-8. Gulf of Aden: Forward area characteristics, shallow-water environments.

Geology
•Bathymetry: <100 m shelf is narrow; shelf steep to ~2000 m deep basin
•Sediment type: shelf is shelly, sand and gravel grain size; high $CaCO_4$ content; basin is mud (foraminiferal)
•Substructure: active rift zone (mid-ocean ridge); oceanic basalts overlain by Tertiary sediments

Hydrography
•Temperature: high, ~30°C at surface; stratified year-round
•Salinity: high, ~36.5 ppt; stratified in summer
•Conductivity: high
•Currents: primarily wind driven; 0.2-0.8 m/s, with maxima ~1.5 m/s
•Tides: mixed; ~1 m range
•Visibility (Secchi): 35 m (winter monsoon) to 15 m (summer monsoon)

Acoustics
•Reverberation: probably high nearshore
•Reverberation variability: probably high
•Sound Velocity: ~1530 m/s
•Sound Velocity variability: negative gradient in upper 100 m

Table 3.2-9. Red Sea: Forward area characteristics, shallow-water environments.

Geology
•Bathymetry: narrow shelf except in southeastern part; narrow, steep-sided basin to ~1500 m depths
•Sediment type: mud, sand, rock on shelf; primarily biogenic (high $CaCO_4$)
•Substructure: rift zone; oceanic basalts; overlain toward basin margins by Tertiary and older sedimentary rocks

Hydrography
•Temperature: high; 25-31°C; moderately stratified
•Salinity: high; 36.5-<39.0 ppt at surface; strong positive gradient with depth due to presence of a sill
•Conductivity: high
•Currents: wind driven; usually <0.5 m/s
•Tides: generally <1 m
•Visibility (Secchi): 15 m nearshore

Acoustics
•Reverberation: probably high
•Reverberation Variability: probably high
•Sound Velocity: ~1530 m/s
•Sound Velocity variability: negative gradient in upper 100 m

Table 3.2-10. Gulf of Sidra: Forward area characteristics, shallow-water environments.

Geology
•Bathymetry: shelf, 10-150 km wide, flat
•Sediment type: sand and rock nearshore
•Substructure: structural basin composed of thick Cenozoic sedimentary series

Hydrography
•Temperature: surface 15-26°C (winter-summer); isothermal to moderately stratified
•Salinity: surface ~37.5 ppt; low gradients
•Conductivity: surface 45-58 mmho/cm (winter-spring)
•Currents: typically 0.2 m/s
•Tides: semidiurnal; 0.3-1.3 m range
•Visibility (Secchi): ~26 m

Acoustics
•Reverberation: generally low
•Reverberation Variability: low
•Sound Velocity: 1515-1540 m/s (winter-summer)
•Sound Velocity variability: negative gradient in summer

Table 3.2-11. Northeast Adriatic: Forward area characteristics, shallow-water environments.

Geology
•Bathymetry: smooth, regular slope
•Sediment type: mud and/or sand
•Substructure: thick sedimentary basin of Cenozoic and Quaternary sediment; borders Alpine belt of deformed Cenozoic sediments to east

Hydrography
•Temperature: surface 10-24°C (winter-summer)
•Salinity: surface ~35 ppt
•Conductivity: surface 40-56 mmho/cm
•Currents: generally ~0.5 m/s except among islands where it may reach 1.5 m/s
•Tides: mixed and semidiurnal; ~0.3 m range
•Visibility (Secchi): 5-15 m (estimated)

Acoustics
•Reverberation: probably high
•Reverberation Variability:
•Sound Velocity: 1445-1530 m/s
•Sound Velocity variability: steep gradients with depth

Table 3.2-12. Panama: Forward area characteristics, shallow-water environments.

Geology
•Bathymetry: Caribbean shelf ~15 km wide; Pacific shelf variable and on the order of 50 km; some coral reefs
•Sediment type: Caribbean: mud, sand, coral, coral debris (including shell and coral heads); Pacific: mud nearshore, sand offshore; occasional patches of coral and coral debris
•Substructure: various rocks; complex deformation caused by plate-boundary stresses

Hydrography
•Temperature: Caribbean: ~27-28°C; Pacific: 20-28°C (winter-summer); low gradients
•Salinity: Caribbean: ~34-36; Pacific: 27-33 ppt (summer-winter); moderate-high gradients
•Conductivity: 45-59 mmho/cm
•Currents: prevailing currents ~0.2-0.5 m/s; winds and runoff may induce locally strong currents of >1.5 m/s
•Tides: Caribbean mixed, range 0.2 m; Pacific semidiurnal, range 3.2-3.8 m
•Visibility (Secchi): Caribbean: ~28 m; Pacific: 4-27 m (winter-summer)

Acoustics
•Reverberation: probably high on Caribbean side, lower on Pacific side
•Reverberation Variability: probably high
•Sound Velocity: 1510-1540 m/s
•Sound Velocity variability: gradients may be present depending on season

Table 3.2-13. Cuba: Forward area characteristics, shallow-water environments.

Geology
•Bathymetry: moderately wide shelf, low slopes
•Sediment type: mud and mud-sand predominate most areas; coarser sediments are coralline sand, shell, and coral
•Substructure: Mesozoic to Cenozoic sedimentary rocks and reef-platform carbonates

Hydrography
•Temperature: 25-29° C; moderate gradient, with little stratification
•Salinity: oceanic, ~35.5-36.5 ppt; during rainy season (May-Oct), nearshore areas may drop to ~23.0 ppt; moderate gradient
•Conductivity: 55-59 mmho/cm
•Currents: nearshore current ~0.5 m/s; tidal currents may reach 1 m/s in certain bays and around islands
•Tides: mixed; range ~0.3-0.6 m max. range
•Visibility (Secchi): 20 m or more

Acoustics
•Reverberation: probably moderate to low
•Reverberation Variability: probably low
•Sound Velocity: 1535-1540 m/s
•Sound Velocity variability: low; negative gradient; affected by low salinity runoff during rainy season (May-Oct)

Table 3.2-14. Korea (east coast): Forward area characteristics, shallow-water environments.

Geology
•Bathymetry: most of <100 m-deep shelf is ~10 km wide
•Sediment type: predominantly gravel and sand (with some shell) nearshore, grading to organic mud offshore
•Substructure: bedrock under thin sediments

Hydrography
•Temperature: surface 3.3-25.6°C (winter-summer); strong stratification in summer
•Salinity: 33-34 ppt; stratified in summer
•Conductivity: 39-49 mmho/cm (winter-summer); stratification follows temperature
•Currents: weak tidal currents; Tsushima and Liman Currents predominate; 0.2-0.4 m/s mean speeds
•Tides: mixed (two unequal highs and lows); range <0.2 m
•Visibility (Secchi): 10-20 m nearshore

Acoustics
•Reverberation: generally high to moderate
•Reverberation Variability: probably high
•Sound Velocity: 1465-1530 m/s
•Sound Velocity variability: variable with depth and location

Table 3.2-15. Yellow Sea: Forward area characteristics, shallow-water environments.

Geology
•Bathymetry: shallow, av. 30 m and smooth in the north, av. 100 m and 20 m irregularities in the south
•Sediment type: mostly mud with muddy sand, and sand, with patches of gravel and rock; some shelly patches
•Substructure: bare bedrock

Hydrography
•Temperature: 1.1-26.0°C (winter-summer, surface); strongly stratified in summer and fall; 100 m temp ~5° C.
•Salinity: 30.0-33.2 ppt (winter-summer surface); strongly stratified in summer and fall.
•Conductivity:
•Currents: predominantly tidal and reversing; speeds 0.2 -0.4 m/s, may reach 1.0-1.5 m/s in restricted areas.
•Tides: mixed; range ~3 m to ~5 m
•Visibility (Secchi): 5-20 m

Acoustics
•Reverberation: generally low except near the SW coast
•Reverberation Variability: low
•Sound Velocity: ~1465 m/s in winter; 1520-1480 m/s (0-30 m) summer
•Sound Velocity variability: little gradient in winter, strong negative gradient below 10 m in summer

3.3 Rationale and Selection of Test Sites

Two sites were initially selected on the basis of in-house data and Mine Warfare Pilots, (1) the Mississippi Gulf Coast/Chandeleur Islands area and (2) the Key West, Florida area. A third site, the shallow shelf off Panama City, FL, was added as a ground-truth area because other related, long-term and ongoing programs have been using this site, allowing a synergistic combination of field efforts with MTEDS.

3.3.1 Mississippi Gulf Coast/Chandeleurs. The region south of the Mississippi Gulf Coast, including the Chandeleur Islands and south and a portion of the Mississippi Fan (Fig. 3.3.1-1) has been selected for the following reasons:

- It is composed of silts and sands similar to shelves in numerous forward areas such as, for example, the Korean shelves, Tobruk, and Tripoli. A difference is that the sediment column is much thicker on the Gulf Coast shelf than on other typical shelves; however, if we consider only the upper 10 m of sediment, that difference becomes unimportant.
- The site is extremely convenient logistically. It is close to the Naval Research Laboratory at Stennis Space Center (NRLSSC) and NAVOCEANO. The area can be reached easily from Biloxi where the R/V *Kit Jones* and R/V *Tommy Munro* (University of Mississippi vessels) are available on short notice. In addition, the ports of Gulfport, Pascagoula, and New Orleans can be used for deeper-draft vessels if required.
- An extremely voluminous historical data base of bottom and subbottom parameters exists. The Minerals Management Service (MMS) is responsible for the management of offshore areas and has compiled a wealth of data that is readily accessible. In addition, there are numerous sources of data from universities (Texas A&M University, Louisiana State University), oil companies and other researchers. NRLSSC Code 7430 has established several test areas in the vicinity of the barrier islands; these areas have been cored and carefully surveyed, and Code 7430 personnel are very familiar with local environmental conditions.
- Good working conditions exist most of the year.
- Water depth ranges from the shoreline to 2000 m down the slope. The hydrography is well known. The water varies from very turbid off the Mississippi River and close to shore, to clear south of the barrier islands and offshore. The salinity also varies widely inshore, depending on the amount of rain and freshwater runoff, and increases with distance from the shore.

We have extended the potential ground-truth area to depths not required by to accommodate and cooperate with a program conducted by H. Fleming, NRL, Code 5110 (Washington, D.C.). By combining the two requirements for test sites, we can economize in terms of labor and acquisition of data, which sometimes can be expensive; however, the specific

potential MTEDS test site subject to the most extensive characterization lies between 29°-30° N and 88°-89° W.

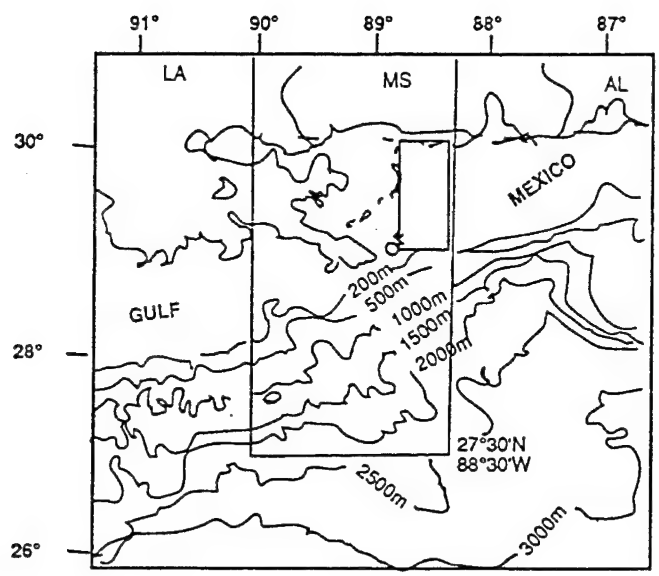
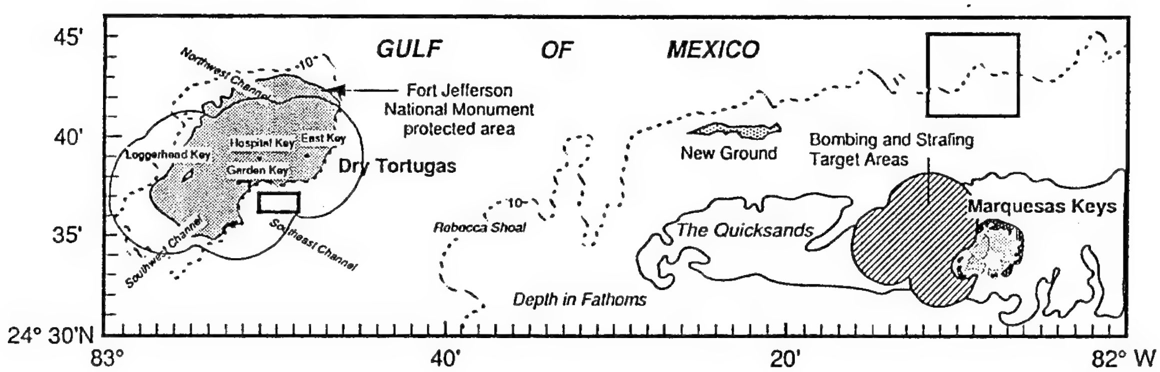


Figure 3.3.1-1 Mississippi Gulf Coast/Chandeleurs MTEDS ground-truth area. The site includes the Mississippi continental shelf, the Chandeleur Islands, and the continental slope south of the Mississippi River. The small box between 29°00′ - 30°10′ N and 88°30′ - 89°00′ W represents an area that has been extensively characterized by NRL.

3.3.2 Key West and Surrounding Area. Key West and the platform and terraces to the north and south (Fig. 3.3.2-1) have been selected because, in addition to being a strategic area in its own right, the region provides an analog for other shallow-water areas, such as exemplified by Cuba and Panama. The Straits of Florida are just off the shelf to the south of Key West and provide similar current and hydrographic conditions to those found in most other straits, e.g., Strait of Gibraltar, Korea Strait, and Strait of Hormuz. The site has the following favorable characteristics:

- It is logistically convenient and operationally inexpensive. NRL has a corrosion facility in Key West with several permanently stationed researchers and multiple contractors who can assist with staging and other needs. The David Taylor Underwater Explosives Research Division is located at Key West and has resources that can be utilized, if necessary. Although the National Oceanic and Atmospheric Administration (NOAA) is now managing the selected area as a Marine Sanctuary, NOAA has indicated that it is mainly concerned about dredging and destructive testing on the living reefs, and sees no problem with the type of experiments which would be conducted by the MTEDS program.
- The area is well documented. An extensive U. S. Geological Survey (USGS) data base and considerable University of Miami research is available. It is also a designated experiment site of the CBBL research program (Richardson, 1992, 1994; Muir and Clay, 1992), which allows MTEDS and CBBL field efforts to be combined.
- The area has considerable environmental diversity. Bottom types range from fine-grained cohesive sediments to sands and gravels in the more hydrographically active regions. It also contains hardgrounds (outcrops) and bottom vegetation which may be encountered in other low-latitude shelf regions. Currents range from quiet to Gulf Steam magnitude (up to 3 m/s) off the shelf.
- The area is a candidate for a planned Acoustic Seafloor Classification System (ASCS) survey to build a carbonate data base for this system.
- The area is a strategically important strait.



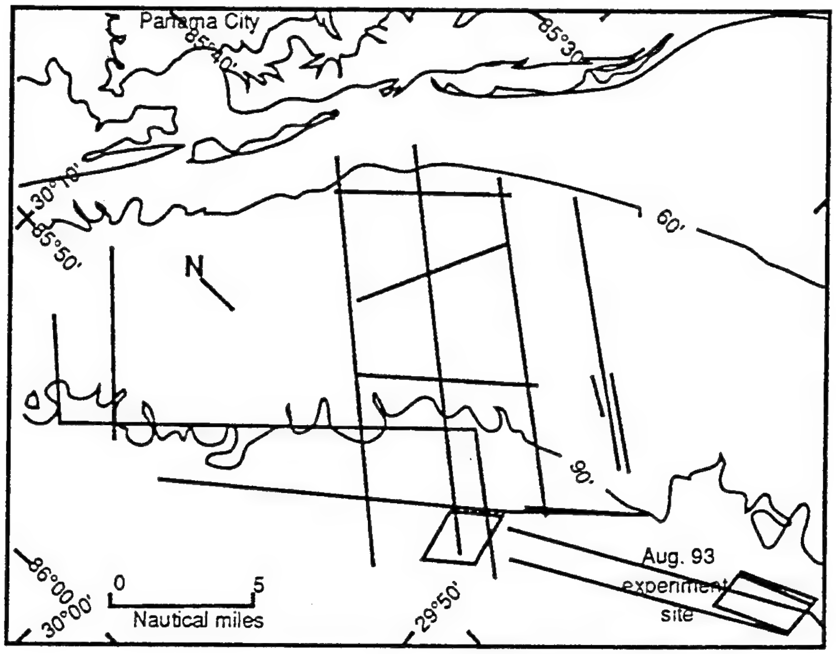
3.3.2-1 Key West ground-truth area, which extends to the north and south of the Florida Keys. Boxes outline areas of primary interest to MTEDS.

3.3.3 ***Panama City Site.*** The shallow shelf off Panama City, FL, was not originally chosen as a Ground -Truth Area. However, because the CBBL (Richardson, 1992, 1994; Muir and Clay, 1992) and the NRL high-frequency acoustics program had planned an August 1993 experiment in this area, the MTEDS program decided to combine field efforts with these two programs. Therefore, the shallow shelf off Panama City was also characterized for the MTEDS program (Fig. 3.3.3-1).

In addition to allowing utilization of existing water column and seafloor information, the Panama City site is advantageous in a number of ways:

- It is logistically convenient. The Naval Surface Warfare Center's Coastal Systems Station (CSS) is located in Panama City, and as joint participants in MTEDS, it can provide extensive logistic support.
- The test site is composed primarily of sandy sediments. A distinct demarcation exists between coarse sands with shell hash in the central portion of the site, and generally fine, homogeneous sands in the surrounding area.
- Considerable information has been documented concerning the nature of this surficial sediment and its lack of variability over the past 10 years. In addition, a substantial quantity of oceanographic data was produced by the predecessors to CSS, the Naval Coastal Systems Center (NCSC) and the U. S. Navy Mine Defense Laboratory.

Other than data collected during high-frequency acoustics experiments in past years, there is little geological data for this particular test site, although recent work conducted by Florida universities provides a sound initial data base for the area in general. Sediment thickness is not accurately known, although preliminary HI-DAPT II™ data collected during the August 1993 MTEDS/CBBL/NRL high-frequency acoustics program cruise suggests that a "basement," a Pleistocene(?) erosional surface, may be about 24 mbsf in the northern portion of the test site. Coring (piston, gravity, and vibracoring) have met with minimal success due to the hardness of the bottom. A fist-sized piece of cemented sand was recovered in a vibracorer core-catcher, suggesting buried hardgrounds immediately below the surficial sands in the site.



3.3.3-1 Panama City ground-truth area. The area marked August 93 was the specific site of the MTEDS/CBBL/High-Frequency experiment. The unmarked area is the site of an earlier High-Frequency Acoustics Program experiment. The lines show previous sidescan sonar surveys. Within each small test site, the bottom was fully mapped with sidescan sonar, and in the case of the August experiment also with 3.5-kHz profiler, chirp sonar, and HI-DAPT II™ remote profiling systems.

4 ENVIRONMENTAL DATA COMPILATIONS FOR GROUND-TRUTH AREAS

This section provides an overview and access to environmental data for the three ground-truth areas selected. Information for each area is provided in three parts: 9a) general site information, (b) a list of data types and sources; and (c) an annotated bibliography of relevant publications (references cited in the body of this report are listed in Section 6).

Background information for the sites, as well as some data from investigations related to MTEDS/CBBL, is shown for general reference and orientation. This information includes location, bathymetry, sediment types, and some sampling locations.

Data types and sources consists of information on data and samples collected during MTEDS/CBBL and related field activities along with the organizations and individuals responsible for collection and analysis of the data. This section also includes information on data bases, primarily oceanographic, from which relevant subsets have been extracted. These data base subsets are available primarily in digital format.

The bibliographies identify sources of geologic, hydrographic, and acoustic data relevant to characterization of the ground-truth areas for the objectives of the MTEDS program. Sources include environmental data sets, as well as background information, regional and site-specific investigations, and program-related information. The bibliographies include materials published through 1994. Note that some references are common to two or all areas, and may appear in each bibliography.

The bibliography is comprehensive, although not exhaustive. All significant sources are represented, including the published research literature, Masters theses and Doctoral dissertations, academic and agency technical reports of research projects, and the reports and compilations of regulatory agencies. The Mississippi Gulf Coast/Chandeleurs is by far the most studied area, and its bibliography, although providing significant and representative citations, is by no means complete. Additional reports and data bases are available from the U. S. Army Corps of Engineers, New Orleans District and Waterways Experiment Station (including the Coastal Engineering Research Center), the Minerals Management Service, New Orleans, LA, and local universities and their associated research organizations, particularly Louisiana State University, Baton Rouge (Coastal Studies Institute and the Department of Geology), University of New Orleans, and the Louisiana Universities Marine Consortium (LUMCON).

As the bibliography reveals, there is considerable duplicative publication of research results. If the user desires information from references that are difficult to obtain, the more accessible associated publications of the authors or agencies often provide the same or similar information. Conversely, the user may find additional information of relevance by tracking the publications of the major cited authors, and by exploring the agency programs that are cited in the bibliography.

Each MTEDS ground-truth area bibliography is ordered chronologically, then alphabetically by author. References are annotated to indicate their principal subject(s), as well as their importance to MTEDS. Annotation is in the form described in the following key:

- Major sources with direct relevance to MTEDS site characterization:
  - **G** Geologic data, including bathymetry
  - **H** Hydrographic data
  - **A** Acoustic and geoacoustic data

- Other sources having some relevance to MTEDS:
  - g Geologic data, including bathymetry
  - h Hydrographic data
  - a Acoustic and geoacoustic data

- *Italics* = Descriptive text that provides additional information about the reference.

4.1 Mississippi Gulf Coast/Chandeleurs

4.1.1 General. The Mississippi Gulf Coast/Chandeleurs site includes the eastern Mississippi River Delta and the continental shelf off Mississippi (Fig. 3.3.1-1). It is predominantly a fine-grained, muddy environment, but includes mixed mud and sandy bottoms. Reef-like carbonate accumulations occur on the outer shelf and upper slope. The site includes medium- to low-energy environments. Sedimentation rates vary from low in the east to extremely high at the delta.

4.1.2 Data Types and Sources, Mississippi Gulf Coast/Chandeleurs.

Acoustic ASCS data, cores, various physical properties from surveys off Ship Island, MS (*Dawn L. Lavoie, Douglas N. Lambert, Naval Research Laboratory (NRL), Seafloor Geosciences Branch, Code 7430, Stennis Space Center, MS, 39529, tel 601-688-4906, fax 601-688-5752).*

Oceanographic and Climatological Data Bases, Digital. Digital data for the Mississippi Gulf Coast/Chandeleurs area are available from four different, generally non-overlapping programs, i.e., the data that appear in one data base generally are not included in the others. The data bases are: Master Oceanographic Observation Data Set (MOODS)/National Oceanographic Data Center (NODC) for both areas; U. S. Army Corps of Engineers (USACE) Dredged Materials project for Mississippi Sound and offshore; Southeast Area Monitoring and Assessment Program (SEAMAP) from National Marine Fisheries Service (NMFS) for Mississippi Sound and offshore; and the Southeast Florida and Caribbean Recruitment Program (SEFCAR) in the Florida Keys area.

In addition, a sound speed data base, based on MOODS, was developed for the Air Defense Initiative (ADI) by George Kerr of NRLSSC. Where MOODS was deficient in salinity/temperature measurements (unfortunately the case in this area), the Generalized Digital Environmental Model (GDEM) of NAVOCEANO was pressed into service to estimate salinities so that expendable bathythermograph (XBT) data could be used to estimate sound speed profiles. *(Dennis M. Lavoie, Naval Research Laboratory (NRL), Code 7333, Stennis Space Center, MS, 39529, tel 601-688-4659).*

MOODS. This NAVOCEANO data base includes all data acquired by NODC, plus restricted data collected by the Department of the Navy and contractors. The data base typically has a 1-yr lag in entry of NODC data.

In the Mississippi-Louisiana area (28°30′ to 30°25′ N by 88°25′ to 89°30′ W), there are 685 records from 1967 to 1989, of these 464 are from hydrocasts, salinity-temperature-depth (STD) profiles, or conductivity-temperature depth (CTD) profiles, from which sound speed may be determined directly. The rest are from XBT profiles, which will require an assumed salinity for sound speed calculation.

The regional distribution of records is from just south of the barrier islands to south of the Mississippi River Delta and eastward from the Chandeleur Islands. No data seem to exist in the shallow sounds. The areal-temporal distribution is spotty; most of the hydrocasts are from 1972.

Data extracted from MOODS include XBT, hydrocast, and a limited amount of CTD data by years from 1967 to the latest records (1988 or 1989) as ASCII data files on two 9-track tapes and Sun Cartridges; optics (Secchi disk/water color) data on 5.25" diskette; current data on 5.25" diskette; and restricted, unclassified XBT profiles and CTD profiles on 9-track tape.

NODC. XBT, hydrocast, and STD/CTD data were acquired for 1988 to 1992 (i.e., data that had not yet been entered into MOODS). Includes 11 XBT stations (file type XBT) in the Louisiana-Mississippi area for the period 1988 to 1992. Data are on one 5.25" diskette.

SEAMAP. This is an on-going NMFS program involving state (inshore) and federal (offshore) surveys emphasizing fisheries potentials. Continuous CTD data are archived, but at present, the continuous data are suspect because of calibration problems. The calibrated data that are available are discrete data, consisting of surface, midwater, and bottom salinity and temperature measurements and color/Secchi measurements. The data were acquired on one 9-track tape in ASCII format. The data set has not been evaluated. ASCII files (& DBF: dBase) on 5.25" diskette and 9-track tape.

USACE Dredge Spoil Study. Data consist of hydrocasts (possibly some STD casts), current measurements, and wind data collected in the Mississippi Sound for the purpose of constructing the USACE Waterways Experiment Station Implicit Flooding Model (WIFM) circulation model. Two 9-track

tapes in obsolete IBM format. *(Data have been transcribed and are available by File Transfer Protocol (FTP) from Dr. Kuor-jier Joseph Yip, University of Southern Mississippi, Center for Ocean & Atmospheric Modeling (USM/COAM), Stennis Space Center, MS, 39529, tel 601-688-3516).*

ADI Sound-Speed Data Base. Shallow-Water Data Base derived from MOODS & GDEM, sound speed profiles. Sun data cartridge.

Oceanographic and Climatic Data, Nondigital

Printouts of SEFCAR and SEAMAP data bases and plots of MOODS data base. *(Dennis M. Lavoie, Naval Research Laboratory (NRL), Code 7333, Stennis Space Center, MS, 39529, tel 601-688-4659).*

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    b) *Carbonate content.*
    c) *Organic carbon percent.*
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gH 1973 Waldrop, W. R. Preliminary river-mouth flow model. Coastal Studies Institute, Louisiana State University, Baton Rouge, Coastal Studies Bulletin No. 7, p. 67-92. *This paper presents progress to date on mathematically simulating, in a three-dimensional array, the flow patterns, density concentrations, and sediment dispersal at a river mouth.*

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and Recent Mississippi sediments that possess a distinctive heavy mineral assemblage.

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Bulletin No. 3, p. 29-53. *The purpose of this study was to attempt to ascertain what happens to the sediment in suspension after it leaves the river mouth. Suspended sediment and hydrographic measurements made off South Pass in summer and autumn.*

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G 1964 Ludwick, J. C. Sediment in northeastern Gulf of Mexico. *In* R. L. Miller, ed., Papers in Marine Geology, Shepard Commemorative Volume, MacMillan, New York, p. 204-238. *Broad coverage, benchmark reference on sediment texture and facies. Mineralogy includes coarsest quartz grains and % leachable material in >0.062 mm fraction (carbonate).*

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Gh 1961 Morgan, J. P. Mudlumps at the mouths of the Mississippi River. Louisiana Geological Survey, Baton Rouge, Geological Bulletin No. 35, Part I, p. 1-116. *The physiography, sedimentary nature, structural characteristics, and developmental history of mudlump islands are discussed. Through a 3-yr investigation of individual islands and exhaustive study of earlier maps and literature, an attempt is made to predict future mudlump activity at the mouths of these passes affected by this phenomenon. Publication of a 1951 dissertation that was sponsored by the USACE.*

g 1960 Hsu, K. J. Texture and mineralogy of the Recent sands of the Gulf Coast. Journal of Sedimentary Petrology, v. 30, p. 380-403 *Mineralogic analysis of beach sands east and west of Mississippi River. Sands to the east are orthoquartzitic and have a staurolite-kyanite heavy-mineral assemblage. Sands to the west are feldspathic and have an amphibole heavy-mineral assemblage.*

G 1960 Lankford, R. R. Facies interpretations in Mississippi Delta borings. Journal of Geology, v. 68, p. 408-426. *A study made of samples cut from borings drilled by the USACE between New Orleans and the Chandeleur Islands and extending to depths of 20 to 60 m in the now abandoned St. Bernard subdelta of the Mississippi River.*

Gh 1957 Ludwick, J. C. and W. R. Walton. Shelf-edge, calcareous prominences in northeastern Gulf of Mexico. American Association of Petroleum Geologists Bulletin, v. 41, p. 2054-2501. *Classic, extensive paper on shelf-edge reef-like structures. Includes bathymetry, sediments, and some hydrography. Study extends eastward from the Mississippi Delta.*

gh 1956 Scruton, P. C. Oceanography of Mississippi Delta sedimentary environments. American Association of Petroleum Geologists Bulletin, v. 40, p. 2864-2952.

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Late Quaternary river-mouth deposits of the Mississippi laid down during the cycle of sea-level change that has occurred since the beginning of the Late Wisconsin glacial epoch.

G 1955 Scruton, P. C. Sediments of the eastern Mississippi Delta. *In* Finding Ancient Shorelines, Society of Economic Paleontologists and Mineralogists Special Publication 3, p. 21-51. *Report on Mississippi Delta building. The rate at which sediments are supplied is faster than the combined effect of the rate at which they are removed by waves and currents and the rate the delta is subsiding.*

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G 1954 Fisk, H. N., E. McFarlan, Jr., C. R. Kolb, and L. J. Wilbert. Sedimentary framework of the modern Mississippi Delta. Journal of Sedimentary Petrology, v. 24, p. 147-194.

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4.2 Key West Ground-Truth Area

4.2.1 General. Figures 4.2.1-1 to 4.2.1-9 provide background information on the Key West site. Included are area location (Fig. 4.2.1-1), generalized bathymetry, and locations of the Dry Tortugas and Marquesas Test Sites for the 1994 and 1995 efforts (Fig. 4.2.1-2), latitude-longitude and Universal Transverse Mercator (UTM) grids (latitude-longitude was the main system used) (Fig. 4.2.1-3), operational constraints (Fig. 4.2.1-4), generalized sediment types (Fig. 4.2.1-5), archival bathymetry at the Dry Tortugas and Marquesas Test Sites (Fig. 4.2.1-6), and bottom sampling and measurement locations (Figs. 4.2.1-7, -8, -9).

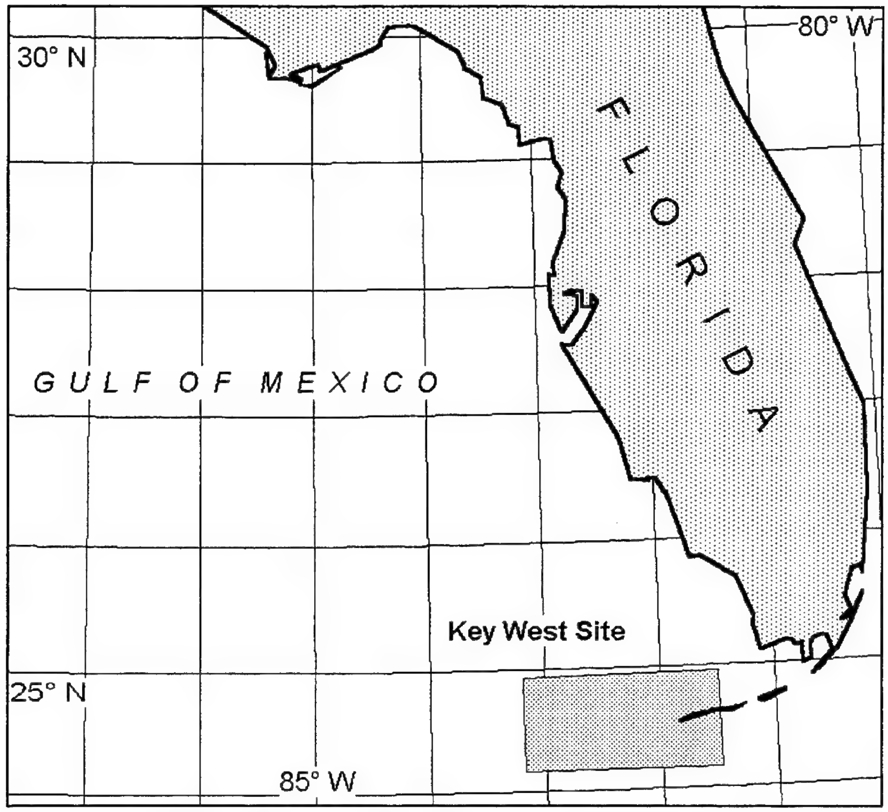


Figure 4.2.1-1. Location of Key West ground-truth area.

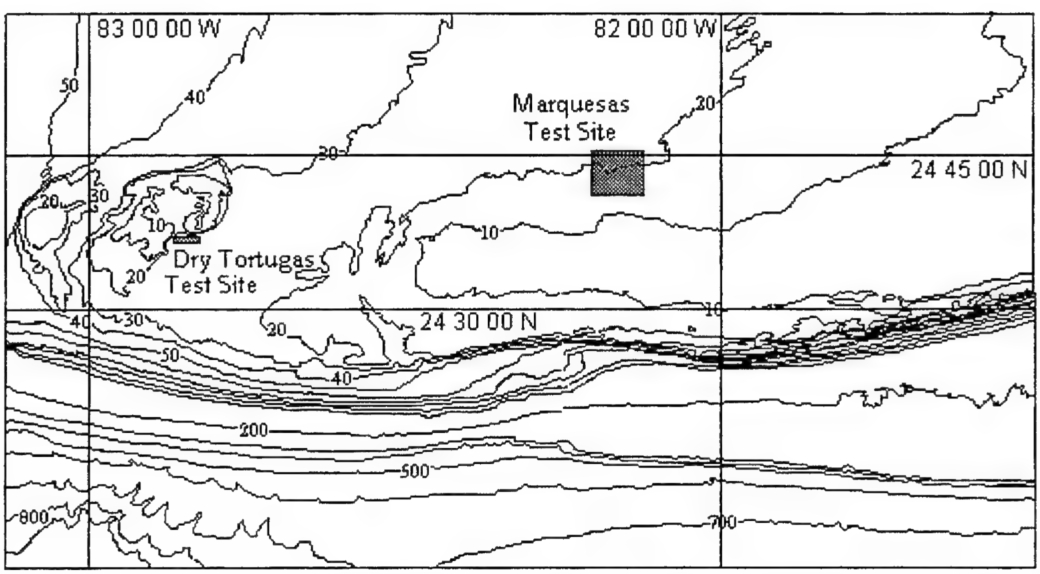
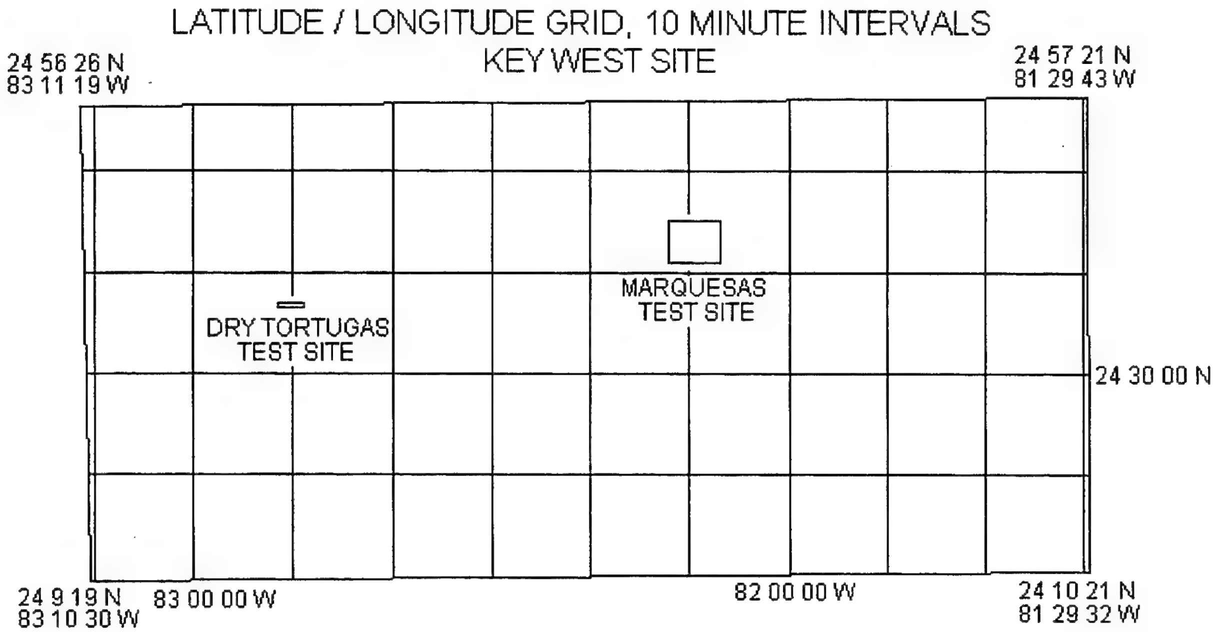


Figure 4.2.1-2. National Ocean Service (NOS) bathymetry, Key West ground-truth area. Contour intervals, 10 m (above 100-m depth), 100 m (below 100-m depth).



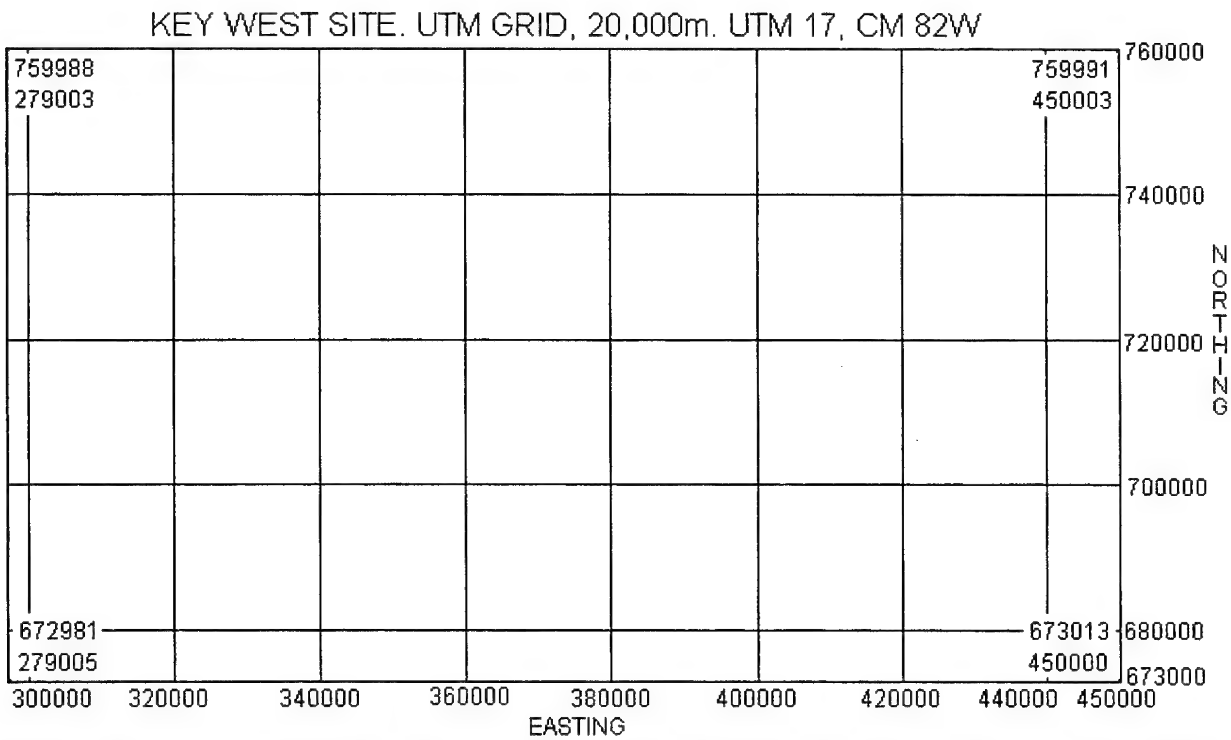


Figure 4.2.1-3. Coordinate grids for Key West ground-truth area. Top, 10-min latitude-longitude grid. Bottom, corresponding UTM projection of above latitude-longitude grid with exact corner coordinates posted.

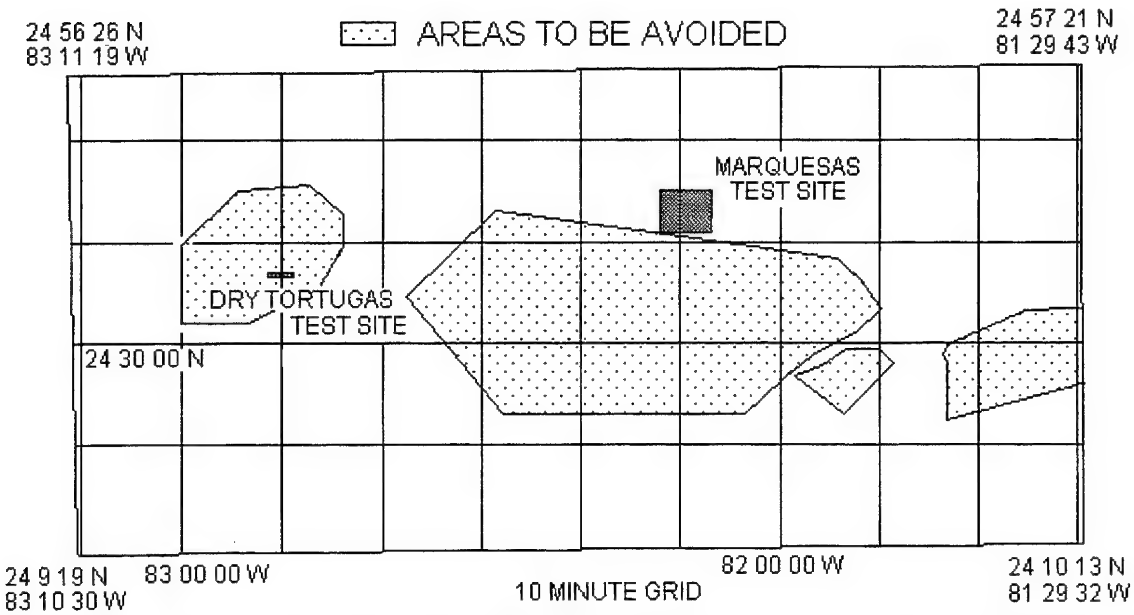


Figure 4.2.1-4. Operational constraints at Key West ground-truth area, based on restricted areas and navigational hazards.

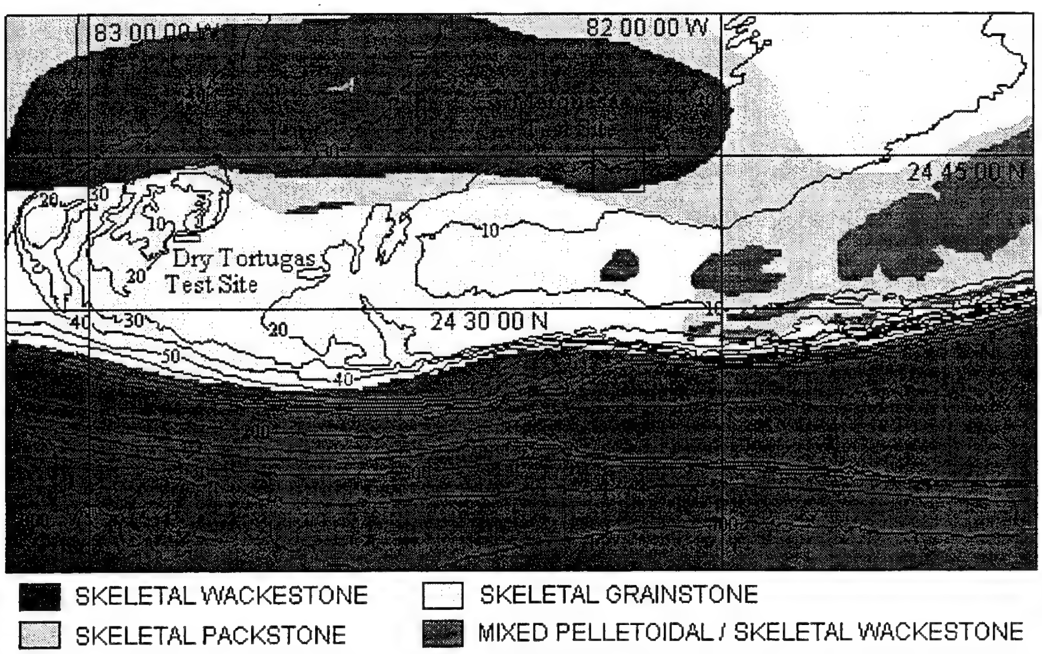
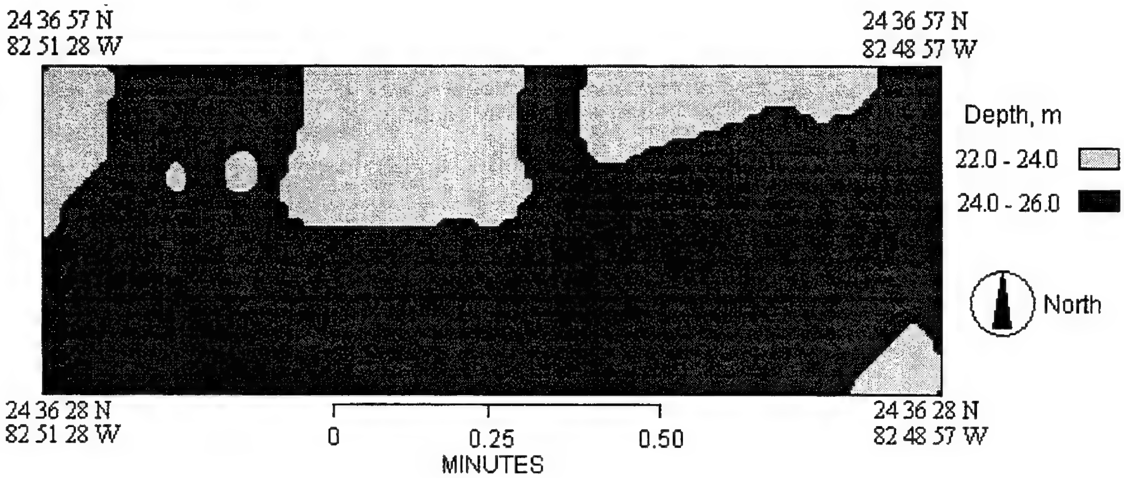


Figure 4.2.1-5. Sediment types from U. S. Geological Survey data and NOS bathymetry, Key West ground-truth area. Contour intervals, 10 m (above 100-m depth,) 100 m (below 100-m depth).



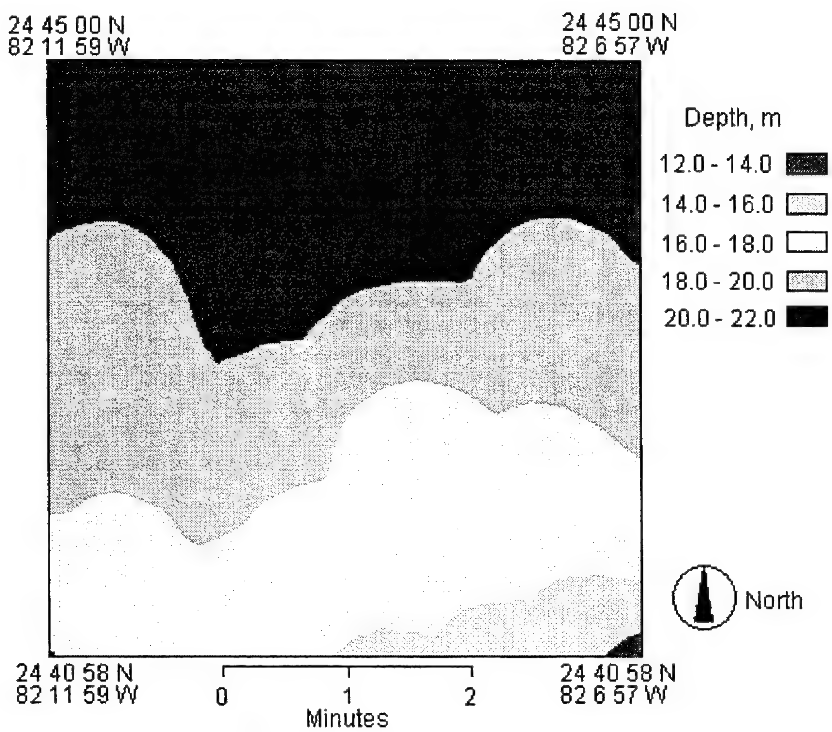


Figure 4.2.1-6. Coordinates and NOS-derived bathymetry of Dry Tortugas (top) and Marquesas (bottom) Test Sites in Key West ground-truth area Test Sites are shown to scale.

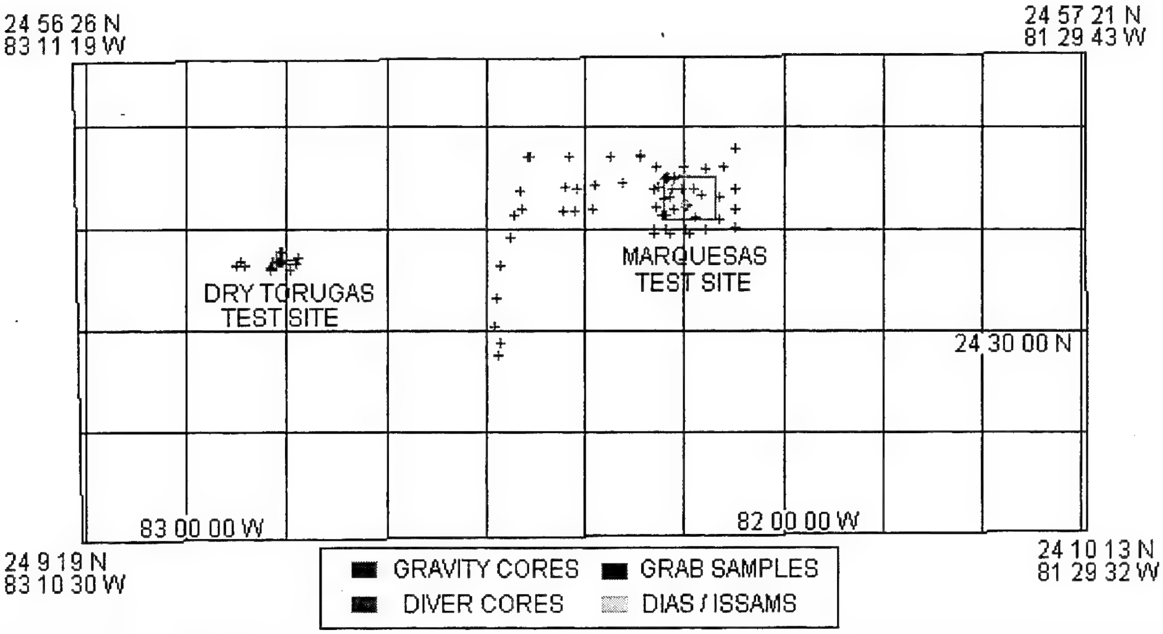


Figure 4.2.1-7. Locations of bottom samples and in situ measurements collected during the 1994 site characterization of Key West ground truth area.

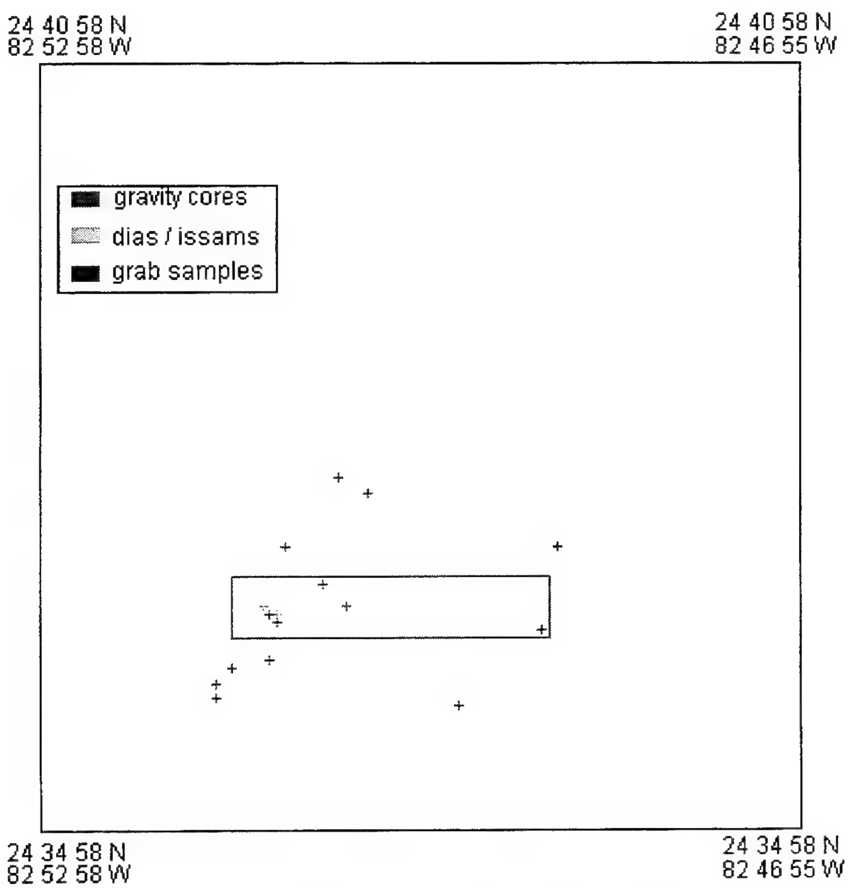


Figure 4.2.1-8. Locations of bottom samples and in-situ measurements collected during the 1994 site characterization of Key West ground-truth area, Dry Tortugas Test Site.

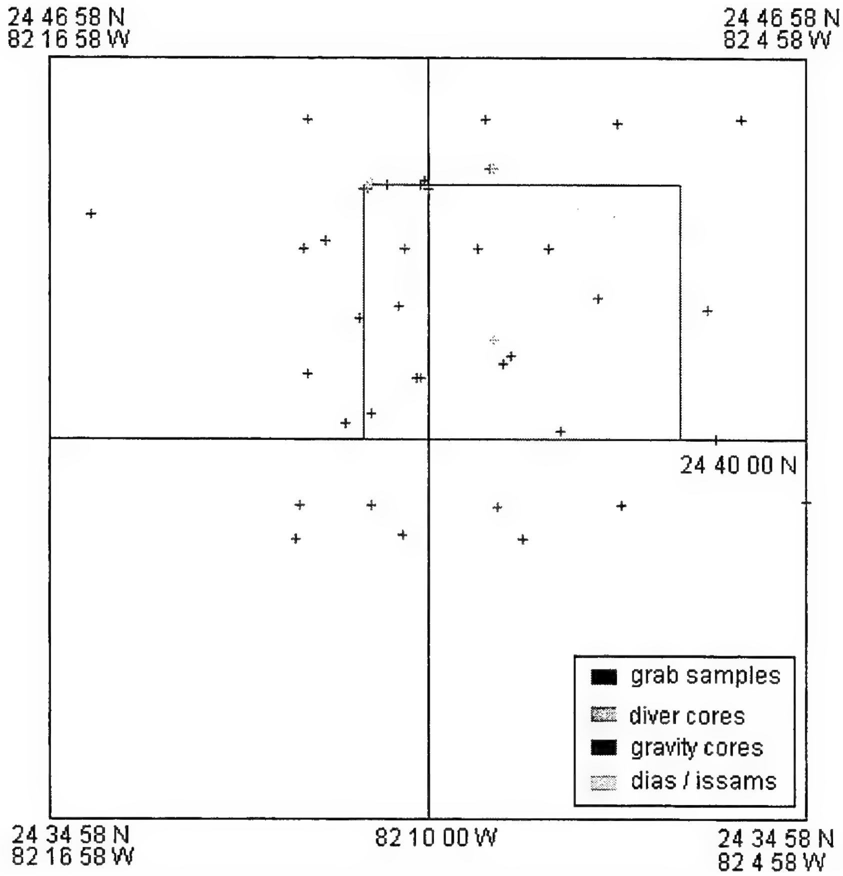


Figure 4.2.1-9. Locations of bottom samples and in situ measurements collected during the 1994 site characterization of Key West ground-truth area, Marquesas Test Site.

4.2.2 Data Types and Sources, Key West

Acoustic Measurements

BAMS (Benthic Acoustic Measurement System) tower, an autonomous bottom-mounted tripod for measuring backscatter at 40 and 300 kHz (environmental instrumentation included a wave buoy and anemometer, Two Sea Bird CTD units); long-term acoustic backscatter data. *(Darrell R. Jackson, Kevin L. Williams, Applied Physics Laboratory, University of Washington (APL/UW), Seattle, WA, 98195).*

Acoustic backscatter data from in situ tower over short term. *(Nick Chotiros, Applied Research Laboratory, University of Texas (ARL/UT), P.O. Box 80, Austin, TX, 78713, tel 512-835-3512, fax 512-835-3259).*

Seismic and Acoustic Surveys

ASCS; 15- and 30-kHz profiler *(Douglas N. Lambert, Naval Research Laboratory (NRL), Seafloor Geosciences Branch, Stennis Space Center, MS, 39529, tel 601-688-4906).*

Magic Carpet (shear wave velocity) *(Angela M. Davis, University of North Wales (UNW), School of Ocean Sciences, Menai Bridge, Gwynedd, LL59 SEY UK, tel 011-44-24-838-2845, fax 011-44-24-871-6367).*

Chirp sonar profiler *(Steven G. Schock, Florida Atlantic University (FAU), Center for Acoustics and Vibration, Department of Ocean Engineering, Boca Raton FL 33431).*

Datasonics chirp sonar, RoxAnn seabed classification system *(Nigel Glover, Dept. CUMW133, Defense Research Agency (DRA), DRA Bincleaves, Weymouth, Dorset, DT4 8 OR, Great Britain).*

Quester Tangent QT C-View bottom classifier *(Jon Preston, Defense Research Detachment, Fleet Mail Office (FMO), Canadian Forces Base(CFB) Esquimalt, Esquimalt, Victoria, BC, VOS1 BO, Canada).*

Sediment density profiler, sediment-strength probe *(Bob Hurst, Defense Scientific Establishment (DSE), NZ Defense Force, Private Bag 32901, Auckland Naval Base, Auckland, New Zealand).*

Seismic and Acoustic Surveys (continued)

100 kHz sidescan sonar *(Hannelore Fiedler, Thomas Wever, Forschungsanstalt der Bundeswehr für Wasserschall- und Geophysik (FWG) Klausdorfer Weg 2/24, 24148 Kiel, Germany, tel 011-49-431-7204-120, fax 011-49-431-7204-150).*

Physical and Geoacoustic Properties

Index properties, in situ compressional and shear wave velocity, mineralogy, pore water chemistry, and selected microfabric, bottom roughness *(Dawn L.*

Lavoie, Kevin B. Briggs, and Michael D. Richardson, Naval Research Laboratory (NRL), Seafloor Geosciences Branch, Code 7430, Stennis Space Center, MS, 39529, tel 601-688-4906, fax 601-688-5752).

Geotechnical properties (strength properties, consolidation) *(Armand J. Silva, University of Rhode Island (URI), Marine Geomechanics Laboratory, Narragansett, RI, 02002).*

Core logger data (compressional velocity and wet bulk density) CT scanned data (density) *(William R. Bryant, Aubrey L. Anderson, Texas A&M University (TAMU), Oceanography Dept., College Station, TX, 77843, tel 409-845-2680, fax 409-845-6331).*

Geotechnical data, in situ penetrometer, shear strength *(Herb Hermann, Naval Facilities Engineering Service Center (NFESC), tel 202-422-5319, fax 202-422-2280).*

Receptivity *(Peter D. Jackson, British Geological Survey).*

Mineralogy, core analyses *(Al Hine, Dave Mallinson, University of South Florida (USF), Dept. of Marine Sciences, 140 Seventh Ave. South, St. Petersburg, FL, 33701, tel 813-893-9161, fax 813-893-9189).*

Mineralogy, Geochemistry

Pore water, bulk composition, microfaunal descriptions *(Yoko Furukawa, Alan Shiller, Charlotte Brunner, University of Southern Mississippi, Center for Marine Sciences (USM/CMS), Stennis Space Center, MS, 39529, tel 601-688-3177, POC Denis Wiesenburg).*

Geochemistry, including isotopes, pore fluids, kinetic modeling *(Christopher S. Martens, University of North Carolina (UNC), Marine Sciences Program, Chapel Hill, NC, 27514, tel 919-962-0152, fax. 919-962-1254).*

Geochemistry, mineralogy, diagenesis *(Charles. W. Holmes, United States Geological Survey (USGS), Box 25046, Denver CO 80225, tel 303 236-7748. After February 1996, St. Petersburg, FL).*

^{210}Pb analyses; thin sections, geological reconstruction *(Charles A. Nittrouer, State University of New York (SUNY)/Stony Brook, Marine Science Research Center, Stony Brook, NY, 11794, tel 516-632-8660, fax 516-632-8820).*

Biology

Bioturbation, biota, colonization; faunal counts *(Glenn R. Lopez, State University of New York (SUNY)/Stony Brook, Marine Science Research Center, Stony Brook, NY, 11794, tel 516-632-8660, fax 516-632-8820).*

Environmental Measurements

Environmental tetrapod instrumented with Benthos camera system, Marsh-McBirney electromagnetic current profiler (five elevations), optical-

backscattering suspended-sediment concentration profiler (five elevations), digital altimeter, pressure transducers. Long-term data (three wks) *(L. Don Wright, Virginia Institute of Marine Science (VIMS), College of William and Mary, Gloucester Point, VA, 23062, tel 804-642-7275, fax 804-642-7250).*

Digital Data Bases with Relevant Oceanographic and Climatological Data. Digital data for the Key West test area are available from two generally nonoverlapping programs, i.e., the data that appear in one data base generally are not included in the other. The data bases are MOODS/NODC and the SEFCAR program.

In addition, a sound speed data base, based on MOODS, was developed for ADI by George Kerr of NRL. Where MOODS was deficient in salinity/temperature measurements (unfortunately the case in this area), GDEM was pressed into service to estimate salinities so that XBT data could be used to estimate sound speed profiles.

Another two interrelated programs have been conducted in the Florida Keys area since about 1987. These are the PEGASUS current profiler program, apparently concerned primarily with Straits of Florida current measurements, and the SEFCAR program, which also emphasized current measurements. Both included CTD measurements at least some of the time, as well as chemical and biological surveys. The PEGASUS data were sent to NODC and, presumably, are included in the acquired MOODS and NODC data summarized below. The SEFCAR data were not available from NODC, and copies were acquired directly *(Dennis M. Lavoie, Naval Research Laboratory (NRL), Code 7333, Stennis Space Center, MS, 39529, tel 601-688-4659).*

MOODS. This NAVOCEANO data base includes all data acquired by NODC, plus restricted data collected by the Department of the Navy and contractors. The data base typically has a one-yr lag in entry of NODC data.

Data extracted from MOODS include XBT, hydrocast, and a limited amount of CTD data by years from 1960 to the latest records (1988 or 1989) as ASCII data files on two 9-track tapes and Sun Cartridges; optics (Secchi disk/water color) data on 5.25" diskette; current data on 5.25" diskette; and restricted, unclassified XBT profiles and CTD profiles on 9-track tape.

Two areas were examined. The first (24°18′ to 24°24′ N, 81°30′ to 83°30′ W) extends from 30 nmi east of Key West to 30 nmi west of the Dry Tortugas, but excludes a significant portion of Florida Bay to the north of the Keys and a portion of the terrace slope. Of a total of 558 records, 364 are XBT profiles, 172 are hydrocasts, and 41 are STD profiles. The spatial-temporal distribution of records places most of the XBT profiles south of the Keys from 1971 onward and most of the hydrocasts and STD profiles within or north of the Keys in the early 1960s. The second area included more of Florida Bay and less of the

Straits (24°24′ N to 25°24′ N) resulted in 318 records of hydrocasts, STD profiles, and one CTD profile. A yearly analysis was not made.

NODC. XBT, hydrocast, and STD/CTD data were acquired for 1988 to 1992 (i.e., data that had not yet been entered into MOODS). Included are 12 CTD stations (file type C022) and 87 XBT profiles in the Key West area. Data are on one 5.25" diskette.

SEFCAR/PEGASUS. The SEFCAR program was a study of sea turtle distribution and dispersion. It and PEGASUS included current measurements with some conductivity-temperature probes mounted on the current meters and CTD transects. These data cover the Key West area for 1989 to 1992 and are on two 9-track tapes in ASCII format. The data also reside at NODC.

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4.3 Panama City Ground-Truth Area

4.3.1 General. Figures 4.3.1-1 to 4.3.1-8 provide background information on the Panama City site. Included are area- and 1993 MTEDS/CBBL experiment locations (Fig. 4.3.1-1); latitude-longitude and UTM grids (Fig. 4.3.1-2), operational constraints (Fig. 4.3.1-3), bathymetry (Fig. 4.3.1-4), a three-dimensional visualization of the site (Fig. 4.3.1-5), detailed NOS bathymetry at the 1993 experiment site (Fig. 4.3.1-6), bathymetry collected during the 1993 experiment (Fig. 4.3.1-7), and sediment sample locations, sediment types, and sediment-bathymetry relations as observed during the 1993 experiment (Fig. 4.3.1-8).

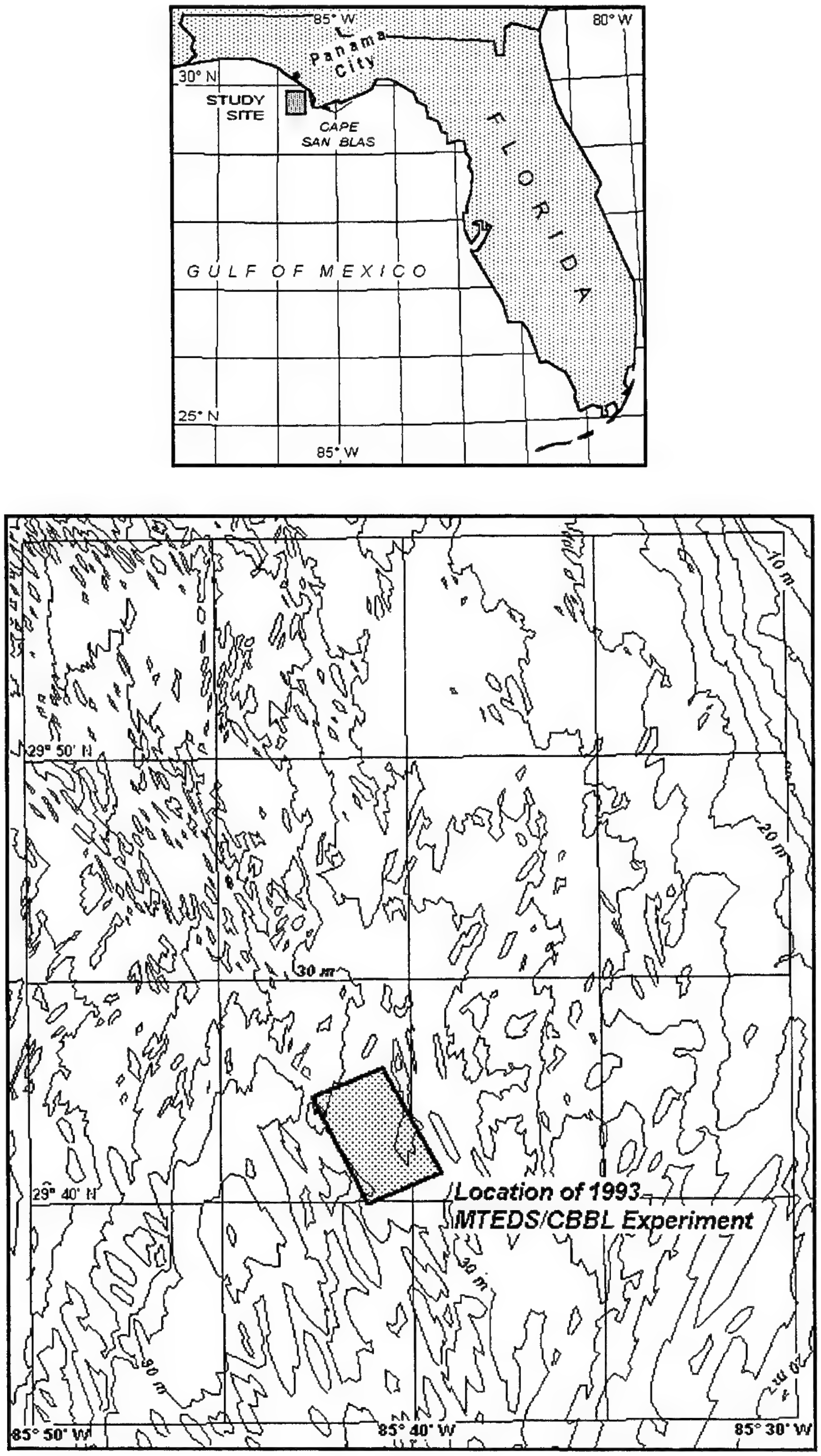

Figure 4.3.1-1. Location of Panama City Site. Top, location map. Bottom, location of experiment site within ground-truth area. NOS bathymetry, contour interval 2 m.

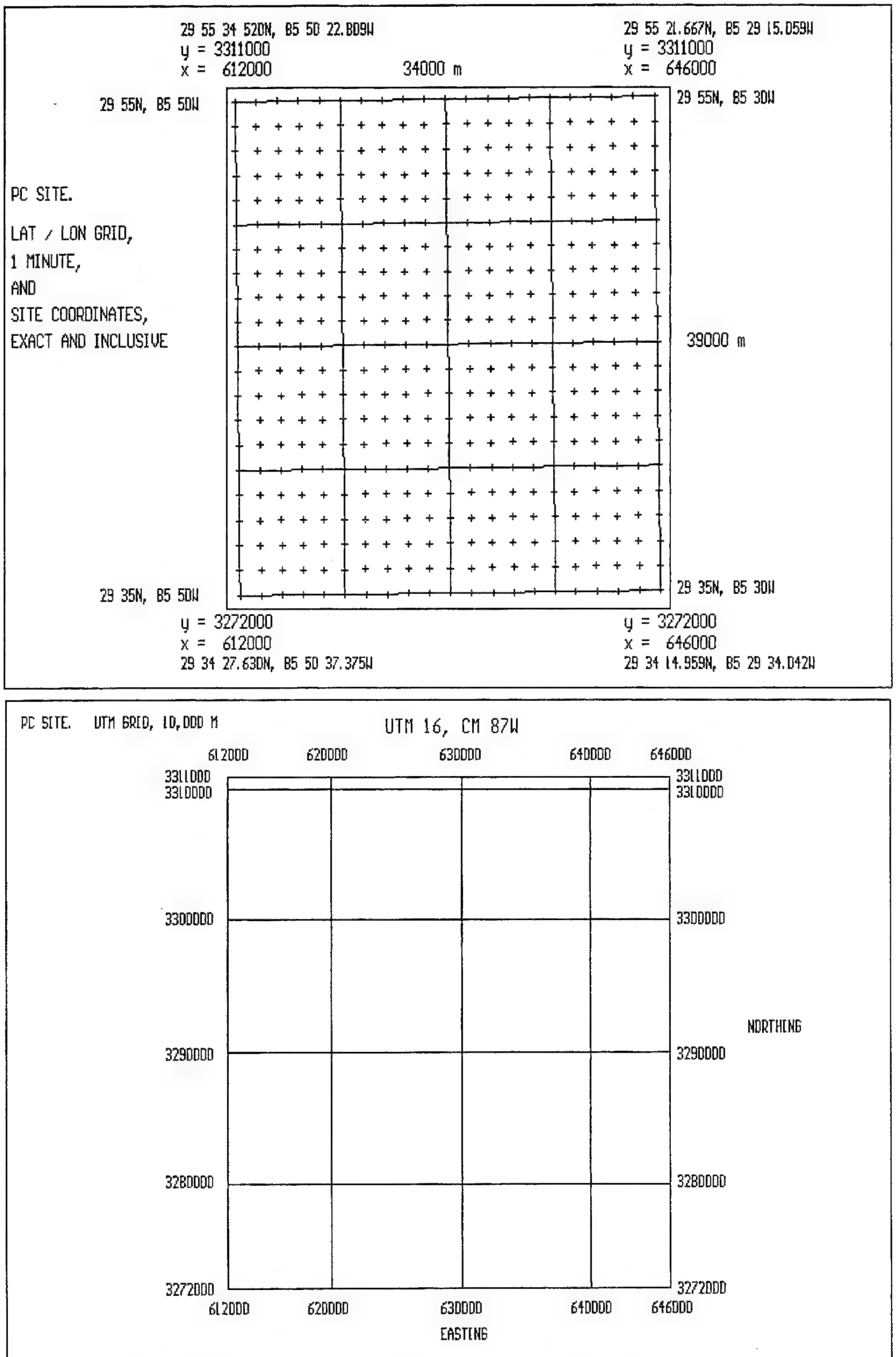

Figure 4.3.1-2. Coordinate grids for Panama City ground-truth area. Top, 1-min latitude-longitude grid on UTM projection. Bottom, defining UTM coordinates and grid.

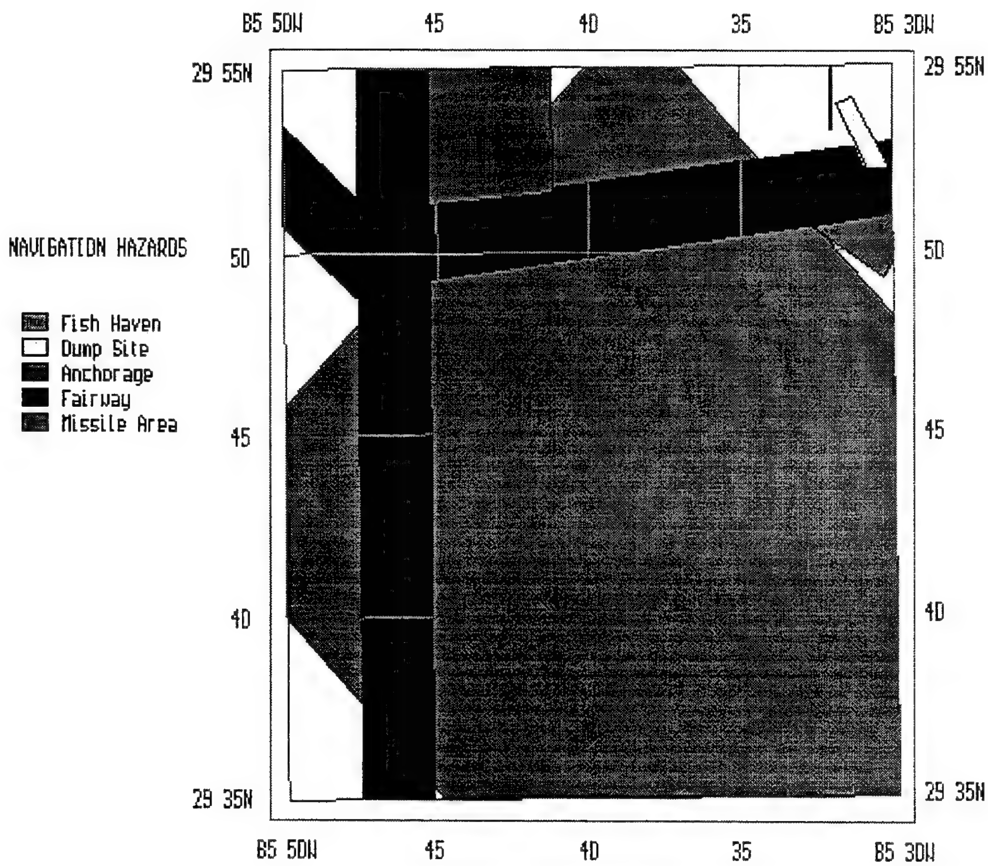

Figure 4.3.1-3. Navigational and potential operational restrictions, Panama City ground-truth area. From NOS charts.

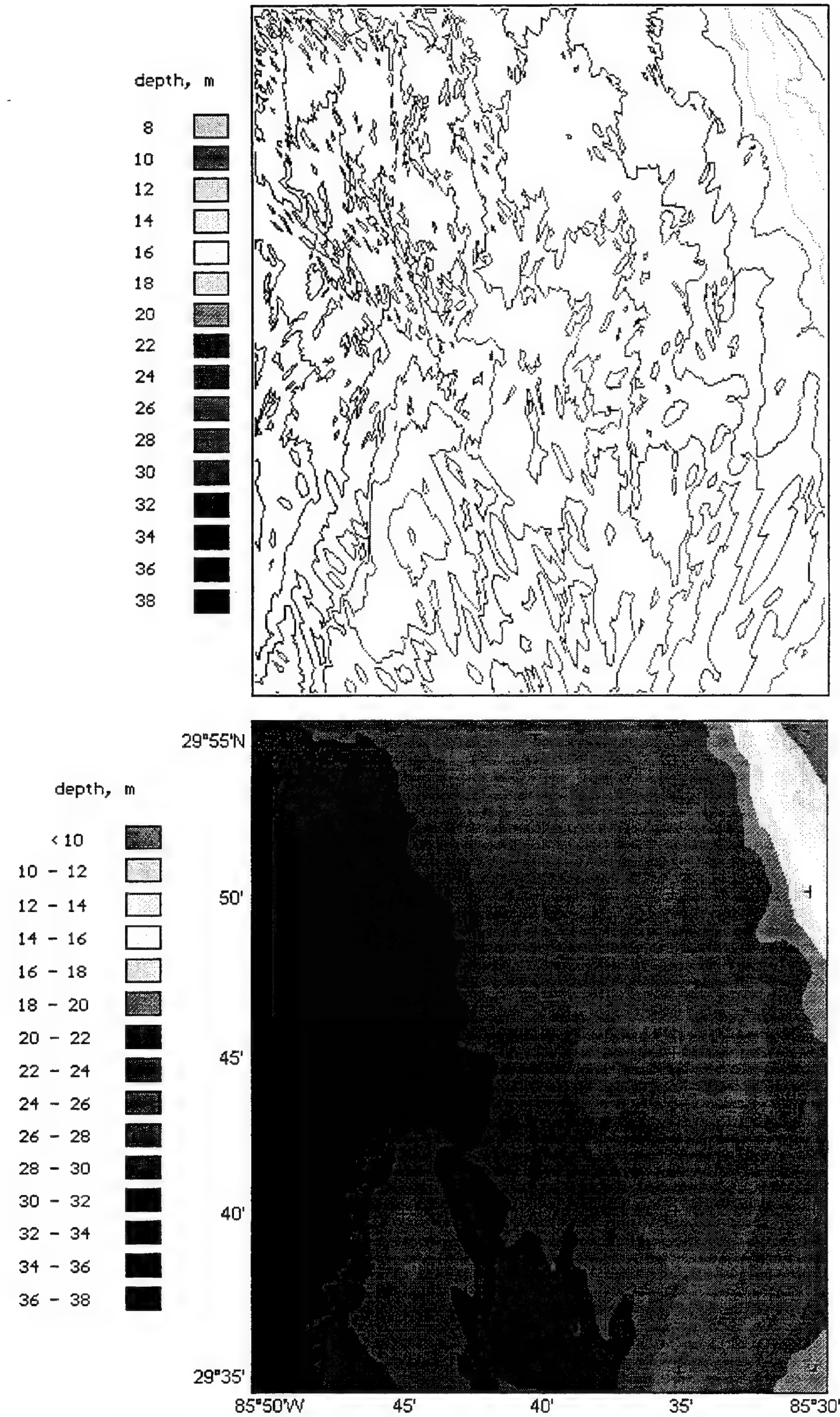

Figure 4.3.1-4. Bathymetry of Panama City ground-truth area. Top, 2-m contours digitized from NOS bathymetry. Bottom, colorfill depth map based on digital elevation model derived from above contours.

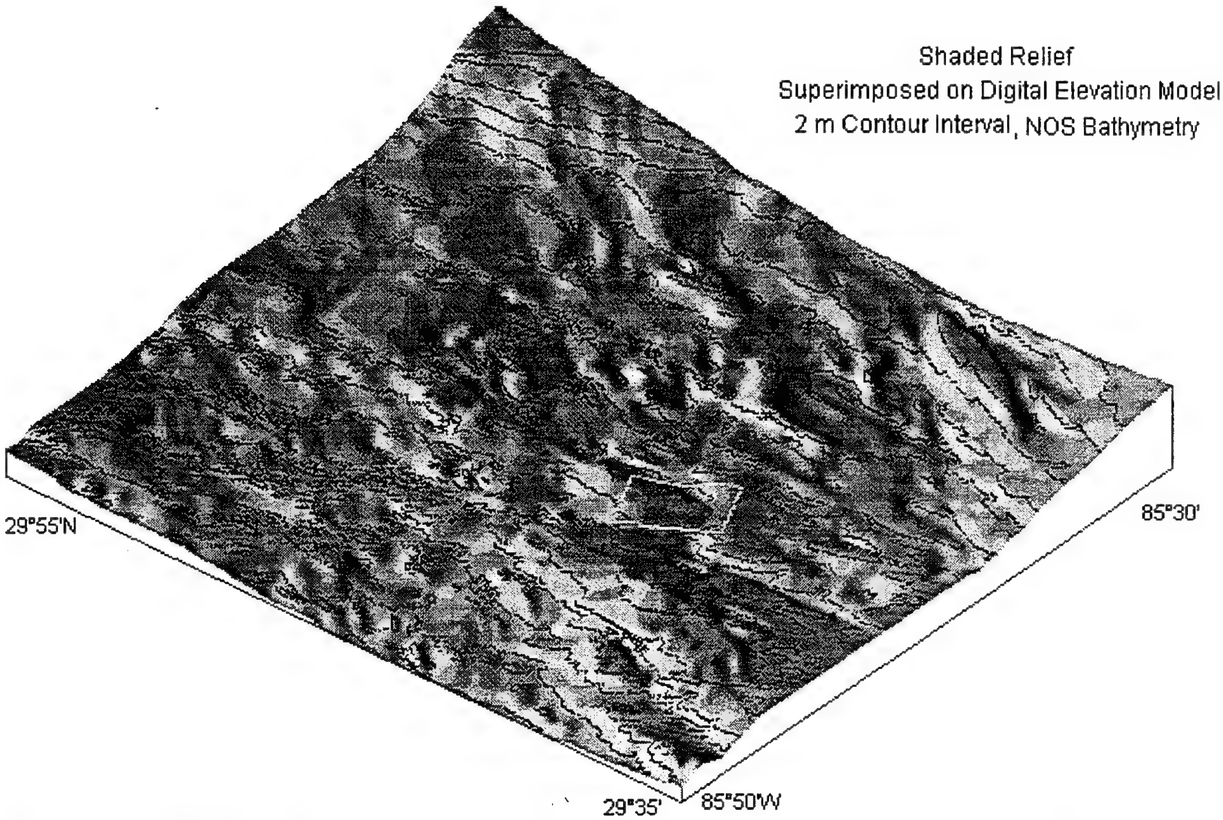

Figure 4.3.1-5. Three-dimensional projection of Panama City ground-truth area. 1993 Experiment site is outlined in white.

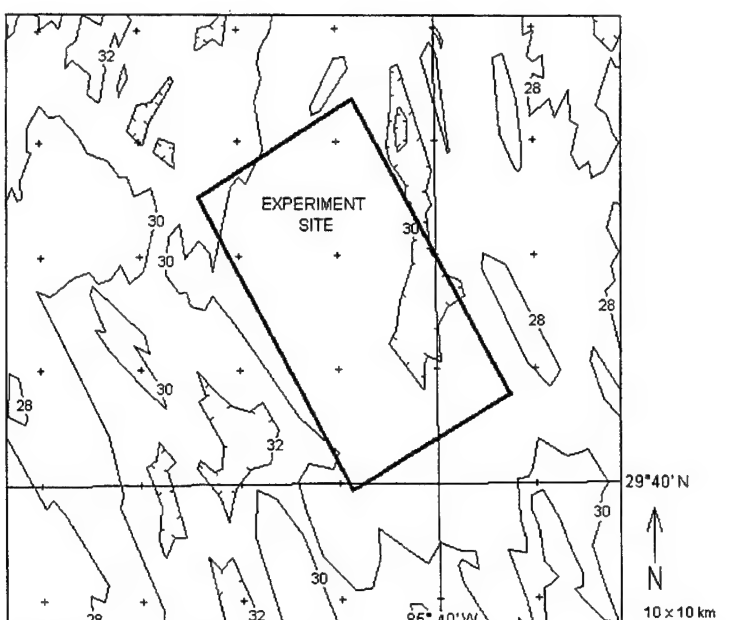

Figure 4.3.1-6. Location of 1993 Experiment Site within small area, 10 km x 10 km, of Panama City ground-truth area. NOS bathymetry.

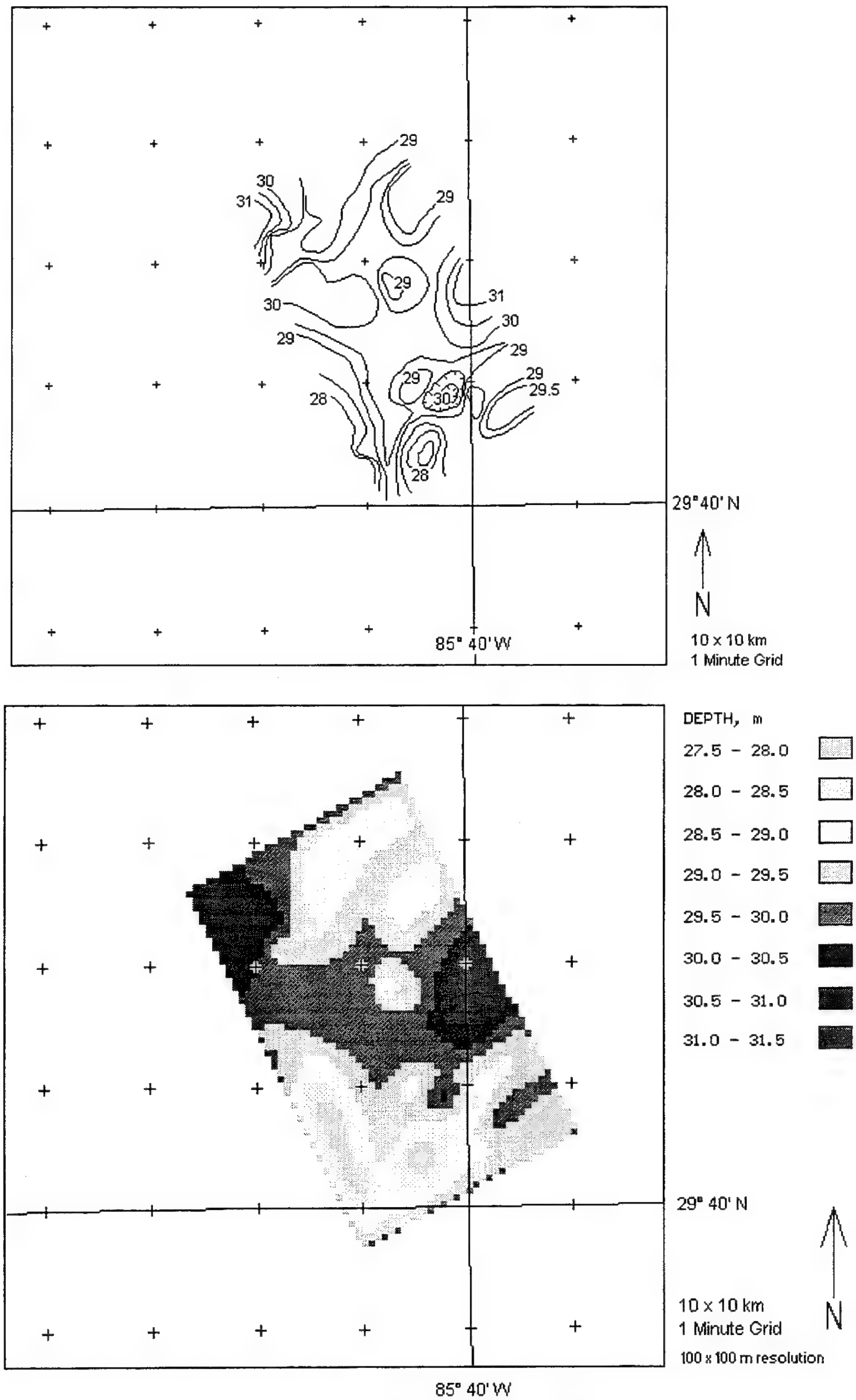

Figure 4.3.1-7. Bathymetry collected during 1993 MTEDS/CBBL Experiment at Panama City Site. Top, 0.5-m contour map. Bottom, colorfill bathymetry. Data from K. Davis.

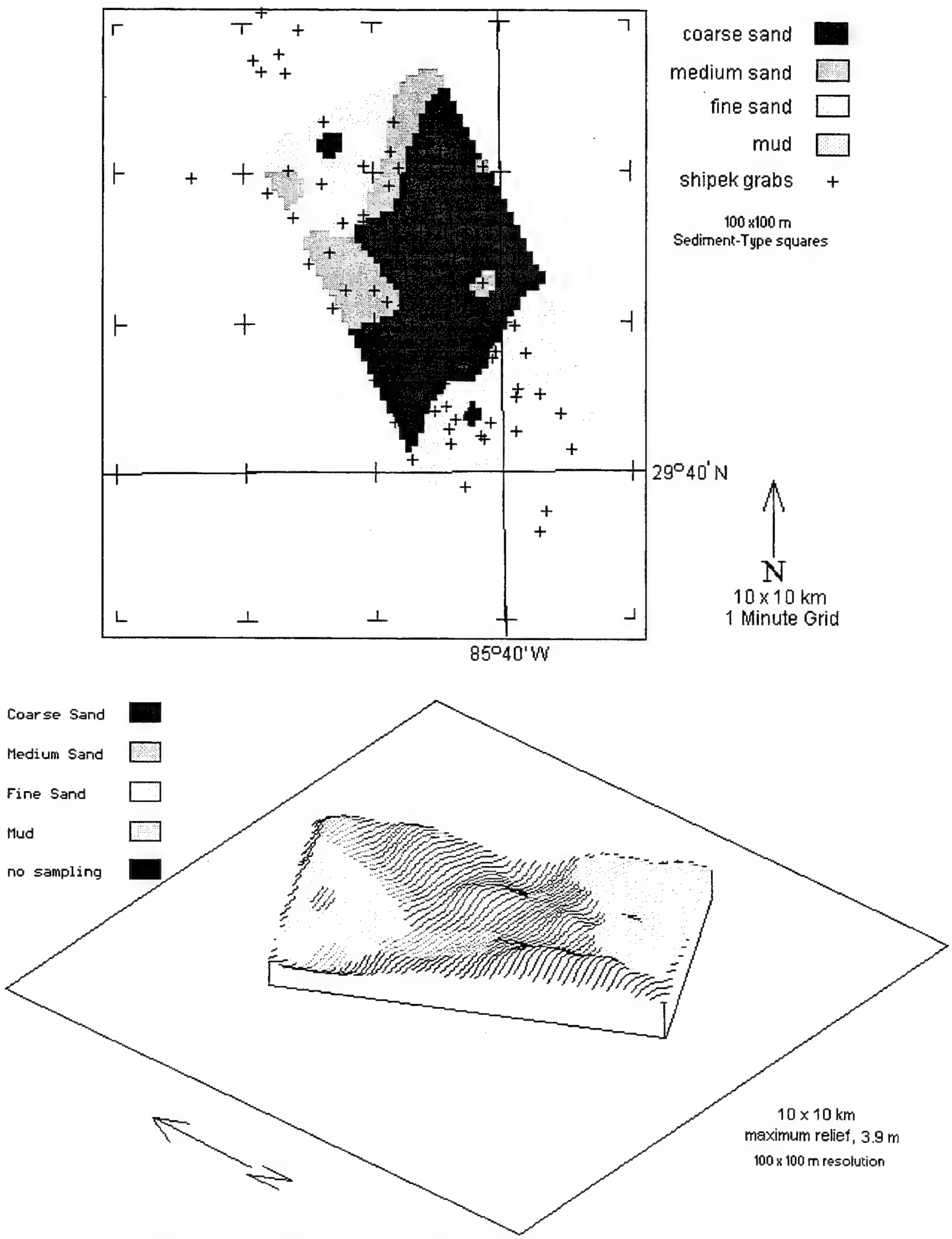

Figure 4.3.1-8. Sediments, 1993 MTEDS/CBBL Experiment at Panama City Site. Top, colorfill map of sediment types with grab sample locations. Bottom, sediment types superimposed on 1993 bathymetry. Data from K. Davis.

4.3.2 Data Types and Sources, Panama City, Florida

Acoustic Measurements

High-frequency long-term acoustic data, both forward and backscatter data *(Steve Stanic, Naval Research Laboratory (NRL), Code 7174, Stennis Space Center, MS, 39529, tel 601-688-5235).*

BAMS (Benthic Acoustic Measurement System) tower, an autonomous bottom-mounted tripod for measuring backscatter at 40 and 300 kHz (environmental instrumentation included a wave buoy and anemometer, 2 Sea Bird CTD units); long-term acoustic backscatter data *(Darrell R. Jackson, Kevin L. Williams, Applied Physics Laboratory, University of Washington (APL/ UW), Seattle, WA, 98195).*

Seismic and Acoustic Surveys

100 kHz sidescan sonar *(Hannelore Fiedler, Forschungsanstalt der Bundeswehr für Wasserschall- und Geophysik (FWG) Klausdorfer Weg 2/24, 24148 Kiel, Germany, tel 011-49-431-7204-120, fax 011-49-431-7204-150).*

Chirp sonar profiler *(Steven G. Schock, Florida Atlantic University (FAU), Center for Acoustics and Vibration, Department of Ocean Engineering, Boca Raton FL, 33431).*

HI-DAPT II™ Subbottom Profiling system; low frequencies, penetrate to 25 m below seafloor *(Peter Hunt, Steve Inkpen [now at Global Environmental Research Group (GERG), Texas A&M University] Centre for Cold Ocean Resources Engineering (C-CORE), Memorial University of Newfoundland, St. John's, Newfoundland, Canada A1B3SX, tel 709 737-2455/8354, fax 709-737-4706).*

Geophysical sled (shear velocity) and in situ shear strength (penetrometer) *(Robert D. Stoll, Lamont Doherty Geological Observatory (LDGO), Acoustical Oceanography Group, Palisades, NY, 10964, tel 914-365-8392, fax 914-365-8156).*

Geological / Geoacoustic Measurements

In situ compressional- and shear-wave velocity, shear modulus, bottom roughness, core analyses (physical properties), 100 kHz sidescan sonar, bathymetry *(Peter Fleischer, Kevin B. Briggs, Dawn L. Lavoie, Naval Research Laboratory (NRL), Code 7430, Seafloor Geosciences Branch, Stennis Space Center, MS, 39529, tel 601-688-4906, fax 601-688-5752).*

Engineering properties, strength data *(Armand J. Silva, University of Rhode Island (URI), Marine Geomechanics Laboratory, Narragansett, RI, 02002).*

Core logger data (compressional velocity and wet bulk density) *(William R. Bryant, Aubrey L. Anderson, Texas A&M University (TAMU), Oceanography Dept., College Station, TX, 77843, tel 409-845-2680, fax 409-845-6331).*

Environmental Measurements

Environmental tetrapod instrumented with Benthos camera system, Marsh-McBirney electromagnetic current profiler (five elevations), optical-backscattering suspended-sediment concentration profiler (five elevations), digital altimeter, pressure transducers. Long-term data (three weeks) *(L. Don Wright, Virginia Institute of Marine Science (VIMS), College of William and Mary, Gloucester Point, VA, 23062, tel 804-642-7275, fax 804-642-7250).*

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5 CONCLUSIONS AND RECOMMENDATIONS

The shallow shelf off Panama City, Florida, became the first site utilized by MTEDS scientists to test potential MTEDS sensors. A second joint MTEDS/CBBL experiment was initiated in the Key West area during January and February, 1994 aboard the R/V *Columbus Iselin*. The objective of this initial cruise was to survey, generally characterize the bottom and subbottom, and select specific locations within the ground-truth area. A full-blown MTEDS/CBBL/High-Frequency Acoustics Program experiment was conducted in February and March, 1995. So far, no MTEDS-specific field operations have been conducted at the Mississippi Gulf Coast/Chandeleurs site.

The three chosen sites offer reasonable analogs to a wide range of forward areas, including (1) sandy, deltaic, low- to medium-energy muddy coasts and environments of mixed sediments, 92) low-latitude, carbonate, and reefal environments, and (3) high-energy, typically mid-latitude continental shelves and tidally dominated coasts. Adequate background information exists for all three areas. Other possibly suitable sites are also identified.

Identification of suitable sites must be based on review and evaluation of existing literature, data bases, and studies. The resulting compilations extend the corporate knowledge base of specific areas suitable for comparative purposes.

The use and extension of such sites, with their knowledge bases, should be considered for future purposes and activities. Such consideration will facilitate cost-effective, timely results.

6 REFERENCES CITED

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7 LIST OF ACRONYMS

A listing of the numerous acronyms and their definitions as used in this report is provided as an aid to the reader. Included are the acronyms used and defined in the text, as well as undefined acronyms in the references and tables.

A&M	[Texas] Agricultural and Mechanical [University]
ADI	Air Defense Initiative
AEAS	Anti-submarine Warfare Environmental Acoustics Support Project
API	American Petroleum Institute
APL	Applied Physics Laboratory
ASCS	Acoustic Seafloor Classification System
AUTEC	Atlantic Underwater Test and Evaluation Center
BAMS	Benthic Acoustic Measurement System
BLM	Bureau of Land Management
BURMMS	Buried Mine Minehunting System
CBBL	Coastal Benthic Boundary Layer
C-CORE	Centre for Cold Ocean Resources Engineering
CFB	Canadian Forces Base
CMS	Center for Marine Sciences
COAM	Center for Ocean and Atmospheric Modeling
COMINEWARCOM	Commander, Mine Warfare Command
CRC	Chemical Rubber Company
CSS	Coastal Systems Station
CTD	conductivity-temperature-depth
DRA	Defence Research Agency
DSE	Defence Scientific Establishment
EIS	environmental impact statement
EM	electromagnetic
FAU	Florida Atlantic University
FIT	Florida Institute of Technology
FMO	Fleet Mail Office
FTP	File Transfer Protocol
GDEM	Generalized Digital Environmental Model
COST GE-1	Continental Offshore Stratigraphic Test well No. GE-1
GERG	Global Environmental Research Group
GLORIA	Geological Long-Range Inclined Asdic
GOM	Gulf of Mexico
L'MAFLA	Louisiana-Mississippi-Alabama-Florida
LANDSAT	Land [Remote Sensing] Satellite
LATEX	Louisiana-Texas Shelf Physical Oceanography Program
LDGO	Lamont-Doherty Geological Observatory
LUMCON	Louisiana Universities Marine Consortium

MAFLA	Mississippi-Alabama-Florida
MCM	mine countermeasures
MMS	Minerals Management Service
MOODS	Master Oceanographic Observation Data Set
MTEDS	Mine Countermeasures Tactical Environmental Data System
NADC	Naval Air Defense Command
NATO	North Atlantic Treaty Organization
NAVOCEANO	Naval Oceanographic office
NCEL	Naval Civil Engineering Laboratory
NCSC	Naval Coastal Systems Center
NFESC	Naval Facilities Engineering Service Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOARL	Naval Ocean Research and Development Activity
NODC	National Oceanographic Data Center
NORDA	Naval Oceanographic and Atmospheric Laboratory
NOS	National Ocean Service
NOSC	Naval Ocean Systems Center
NRL	Naval Research Laboratory
NRLSSC	Naval Research Laboratory, Stennis Space Center
NZ	New Zealand
OCS	outer continental shelf
OSU	Oregon State University
OTEC	Ocean Thermal Energy Conversion
PEGASUS	a current velocity profiling instrument (not an acronym)
POAC	Port and Ocean Engineering under Arctic Conditions
RSMAS	Rosenstiel School of Marine and Atmospheric Science
SEAMAP	Southeast Area Monitoring and Assessment Program
SEFCAR	Southeast Florida and Caribbean Recruitment Program
SEPM	Society of Economic Paleontologists and Mineralogists
STACS	Subtropical Atlantic Climate Study
STD	salinity-temperature-depth
SUNY	State University of New York
TAMU	Texas Agricultural and Mechanical University
TOTO	Tongue of the Ocean, Bahamas
UNC	University of North Carolina
UNW	University of North Wales
URI	University of Rhode Island
USACE	United States Army, Corps of Engineers
USF	University of South Florida
USGS	United States Geological Survey
USM	University of Southern Mississippi
UT	University of Texas

UTM	Universal Transverse Mercator [projection]
UW	University of Washington
VIMS	Virginia Institute of Marine Science
WHOI	Woods Hole Oceanographic Institution
WIFM	Waterways Experiment Station Implicit Flooding Model
XBT	expendable bathythermograph